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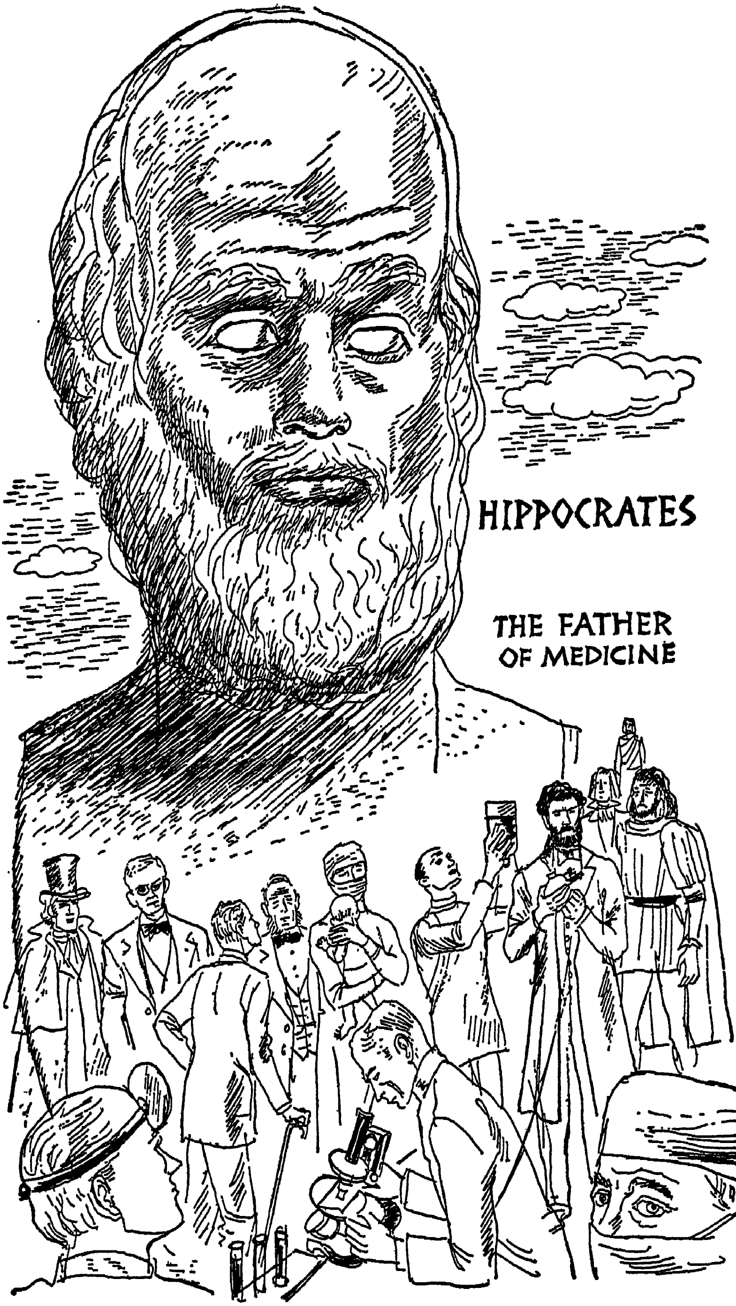
HIPPOCRATES
THE FATHER OF MEDICINE

*The True Adventure Library*
EDITED BY MANUEL KOMROFF

# *True Adventures of* DOCTORS

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*True Adventures of*

# DOCTORS

# 1

## *With His Feet upon the Ground*

AMBROISE PARÉ, 1510–1590

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IN 1536 the French Army crossed the Alps on the way to attack Turin. The third war between François I and Charles V had begun; like the two previous ones it would be fought on Italian soil, with Milan for the prize. However, King François of France was certain it would differ from the others in one most important respect: this time he would be victorious.

With the infantry of Maréchal de Montejan rode a French regimental surgeon named Ambroise Paré, a robust young man with high cheekbones, a sparse beard and a scraggly mustache, plenty of unruly hair and exceptionally keen eyes. Not yet a master barber-surgeon, he could not legally practice his craft; but the army didn't care about that. With all the fighting of recent years, it was so badly in need of men to care for the wounded that it accepted apprentices.

Paré had learned all he could at the Hôtel-Dieu, Paris's public hospital, and rather than serve an apprenticeship

under an older man, he had joined the army to gain experience enough to be able to take his examinations and practice on his own. He had liked the hospital although much of his work there had been menial, which was to be expected since he was training to be a barber-surgeon, and it was a humble craft. Aside from shaving and trimming beards and hair, barber-surgeons were supposed to be restricted to letting blood (a regular procedure in treating almost any illness) by opening veins with their razors and by cupping and leeching. Lately, however, they had been taking over some of the tasks of the Surgeons of the Long Robe. This group ranked far above the barber-surgeons, and equally far below the physicians.

Physicians, being learned philosophers, impressed Paré, but Surgeons of the Long Robe struck him as a pretty useless lot. They seldom bothered to operate, limiting themselves to using the cautery and to applying ointments and plasters. Even the dressing of wounds, which was one of their prerogatives, was gradually being taken over by the barber-surgeons.

"I'd rather be a humble barber-surgeon with his feet upon the ground than a Surgeon of the Long Robe with his head in a cloud of theories," Paré had once remarked to a friend at the Hôtel-Dieu.

Sometimes he had regretted the fact that he did not know a word of Latin, for most books on surgery were written in that language. Still one could learn a great deal by keeping one's eyes open. And the anatomical lectures

of the faculty of medicine, which he was permitted to attend, were a great help to him in dissecting.

He had looked forward eagerly to the experiences he would have in the army, only to find them very slow in materializing. There were times when he was convinced he would never do anything but sit on the back of a plodding horse — but at least he was better off than the foot soldiers.

He was far more favorably impressed with these men than he had expected. Generally regarded as the scum of the earth, they were, he soon realized, a decent, good-hearted crowd in spite of their rough ways. It seemed shocking to him that such men should be killed if they were wounded too badly to march with their regiments, but they themselves said it was better than falling into the hands of the peasants, who hated the invaders that were despoiling and devastating their lands. Paré resolved to figure out some way of taking the wounded along; surely room could be made for them in the supply wagons if their comrades pitched in and carried some of the supplies. Heavily burdened though they were, Paré was sure they would help out.

That, however, was for the future. As yet nothing more than an occasional skirmish had come his way, providing him with a few wounds to dress. One of these had already given him a bit of a reputation, since it was on the person of an officer who had believed himself to be fatally wounded. Paré did not consider himself entitled to the

credit for the captain's recovery. "I dressed his wounds and God healed him," was the way he put it, in all sincerity. Dressing wounds was nothing new to him; his real test would come later when he had to tend to men who had just been struck by bullets. So far he had not seen a gunshot wound directly after it had been inflicted. He was still, he thought, a freshwater surgeon, the equivalent of a sailor who had not been on the ocean.

Paré knew how gunshot wounds were supposed to be treated. Fortunately a book on the treatment of wounds had been translated into French, and it was quite explicit in its instructions. The book said that gunpowder was poisonous and bullet wounds were therefore filled with venom which had to be destroyed with boiling oil. This theory and this method were generally accepted. The boiling oil, by causing the ends of severed blood vessels to shrivel up, also tended to prevent the wounded from bleeding to death.

Knowing how painful this method was, Paré asked the experienced surgeons whether it was the one they employed.

"Of course," one of them said, "except that I always mix a little treacle with the elder oil, in order to encourage healing."

Another surgeon advocated the use of theriac — the mixture that was a universal antidote to poisons. "I have an excellent theriac containing viper's flesh and bezoar stone," he told Paré. "I don't suppose you know where I could get a bit of powdered unicorn's horn?"

Paré shook his head. While he did not doubt the value of the ingredients they mentioned, something else was on his mind. "Is there no remedy other than boiling oil? I've often thought it was an unsatisfactory method of controlling bleeding, since bleeding is apt to begin again as healing proceeds and the scabs drop off."

"It's as good a way as any to stop bleeding, and it's the only way to prevent poisoning. Unless it is done promptly, the wounded will die in great agony, perhaps in a few hours, surely by the next day, after the manner of those bitten by a venomous asp."

Paré was convinced.

Things were going well for the French. The enemy was retreating, and Paré's regiment, marching into a city that had surrendered, was savoring victory almost before it had tasted battle.

Yet as Paré rode into the vanquished city, he saw the heavy price others had paid. The bodies of the enemy lay piled in the streets, humble men like himself, who had fought for their emperor, Charles the Fifth, as he would fight for François of France.

Then, suddenly, he heard a cry from beneath the hoofs of his own horse. Horror-stricken, he realized that he, Ambroise Paré, was riding over the bodies of men who were still alive. From the bottom of his heart he wished he were back in Paris tending the patients at the Hôtel-Dieu instead of adding to the suffering of the wounded.

It was the first time he had realized how dreadful war could be.

It was brought home to him still more forcibly a little later. Seeing a stable, he headed for it in order to quarter his horse before he went to tend to the wounded. There, propped up against a wall, were some enemy soldiers, their clothes still smoldering from gunpowder which had evidently exploded. Looking more closely, Paré saw that four of the men were dead, but that the other three were still breathing, although unconscious.

"Can anything be done for them?" Directly in back of Paré stood one of his foot soldiers, his grizzled beard matted with dust and perspiration.

Paré stooped over to look more closely at the unconscious men. Without touching them, he knew. "Nothing can be done," he said.

The old veteran slipped the heavy harquebus off his right shoulder and set it against the wall. Drawing his knife, he deliberately cut each of the three men's throats.

Paré cried out indignantly, "How can you do such a brutal thing to those helpless men?"

The old soldier looked at him. Humble as barber-surgeons were, they were far above a common infantryman; yet Paré's face told him he dared speak up frankly. "I pray to God that if I am ever in their place, someone will do as much for me, and not leave me to languish miserably," he said.

Deeply touched, Paré laid his hand on the veteran's shoulder. How could he say it was wrong to kill men out

of pity when the soldier's life was devoted to killing them for the glory of his king?

He was too busy to think about that now. Although the city had surrendered, many of the enemy had escaped to the castle of Villaine, where there was a garrison of some two hundred Spaniards. There they felt they were safe, for the castle was on a hill, and the French artillery could scarcely damage its walls if the cannon had to be aimed upwards. The French guns were as good as any, but they were useful only at close range or if they could hurtle cannon balls down from a height.

Maréchal Anne de Montmorency, constable of France, who commanded the army, had ordered that no enemy strongholds should be left in the rear; and so Villaine would have to be taken. But how could that be done without the help of cannon to make a breach in the walls?

It was true that there was one spot outside the fortress that was almost as high as the hill on which the castle stood, but the defenders did not worry about that, being certain that cannon could not possibly be dragged up so steep and rocky a slope. The French, however, determined to do just this.

All night long the French soldiers struggled desperately to get their two cannons to this vantage point. Toward morning they succeeded. Then, just as they were about to begin the bombardment, one of the gunners carelessly set fire to a sack of gunpowder. It not only burned him and a dozen of his comrades, but revealed their position to the enemy. Immediately the enemy fired in the

direction of the cannons, killing and wounding scores of men. But at last, after many hours, the French artillery succeeded in making a breach through which the infantry streamed. The castle's defenders fought desperately, inflicting many casualties before they were forced to yield.

Now Paré was put to the test. The enemy had fought with arrows and pikes, had even hurled rocks from the castle walls, but the majority of the wounds had been made by bullets of great size.

He worked rapidly, using what he had learned and, when that was not enough, relying on his own common sense. When he was unable to locate a bullet which had to be removed, it occurred to him that he could figure out its course by finding out what position the soldier had been in when he was struck. Even though he had not read that in any book, he tried it and it worked pretty well. Then he scalded the wound as rapidly as he could, steeling himself for the pain he had to inflict. If the wound was too narrow or too deep for the oil to penetrate, he thrust setons (bristles) hot with oil into it. Then he applied the dressings.

He had never imagined there could be so many wounded. On and on he worked, until he was so tired he wondered how he could ever have complained about doing nothing except sit on the back of his horse. When the oil in the cauldron ran low, he would send a soldier for more, throwing wood on the fire himself to keep it going until the man came back. Toward evening, however, the

soldier he sent was gone so long he told another man to go after him. Meanwhile he used the remaining oil as sparingly as possible.

"What's kept you?" he demanded when the two men returned together. "And why haven't you brought the oil?"

"There is no more," they told him.

Unable to believe it, he went to see for himself. They were right; there was no more oil. What could he do now? For an instant Paré was tempted not to return to the wounded, but to hide himself somewhere, anywhere, so that he would not have to see the men whom he was powerless to help. There was nothing he could do for the ones who, since he had no boiling oil, were doomed to die from the poisons in their wounds.

But he went back. He couldn't bring himself to put them out of the misery they faced, so he would at least give them the comfort of thinking something was being done for them. Perhaps in a few cases the Lord might perform a miracle; after all, people had been known to recover from the bite of a poisonous snake.

He wondered whether to heat a cautery in order to sear the ends of their severed blood vessels and at least stop the bleeding. But no, since they were almost certain to die, he could at least spare them that agony. He would plug up the wounds with lint, which was almost as good as heat in stopping bleeding. On the lint he smeared a mixture of egg yolk, attar of roses, and turpentine to act as a medicament. His conscience troubled him because the soldiers

were so grateful for his makeshift efforts, but he felt he owed it to them to hide his concern and at least give them the comfort of having their wounds dressed and bandaged.

When at last he was finished, he was so exhausted he fell onto the ground, pulled his cloak over him, and expected to forget everything until morning. But he could not sleep. All night long he thought of the men who must be dying, their bodies swollen and black like that of a man he had once seen killed by an adder's sting. Several times he was on the point of getting up and going to them, but there was nothing he could do, and the dying men needed a priest rather than a barber-surgeon.

At the first streak of dawn he was up, hurrying to the row of men he had treated after the oil ran out.

He could scarcely believe it when the first one told him, "I rested pretty well, I even slept some of the time." The man's brow was cool to the touch. As the sun slowly rose, Paré removed the bandages from the wound; it was neither swollen nor inflamed. The man's breathing was regular, his eyes were clear. It was incredible, it was against everything Paré had been taught—but he was certain there was no poisoning here.

Down the row he went, and one after another of the wounded told him the same story. Some of them were far gone from the severity of their injuries, but not one showed any signs of having been poisoned.

When he reached the men he had treated in the approved manner, it was a different story. They were hot

and restless, their wounds painful and swollen — as was usual with surfaces that had been burned.

Standing there in the pale morning light, Paré thought it over. Physicians and surgeons agreed that gunpowder was poisonous, that the wounded would certainly die of it unless its potency was destroyed by heat. Yet he had seen men — not just one or two but a number of them — who showed no signs of poisoning even though their wounds had not been treated with hot oil. Burns heal slowly and

painfully; why, then, should a wound be burned if it was not necessary?

This was Paré's first experience with front-line surgery. But already he had learned something important, by drawing conclusions from what he observed instead of believing what he had been taught.

To the men whom he had treated in the approved manner and who had suffered needlessly, he made a solemn promise. Never again, he resolved silently, will I thus cruelly burn the poor men wounded by gunshot.

Having concluded that bullets were not actually poisonous, Paré set about finding something less painful than heat to use in order to stop bleeding. Plugging the wounds with lint was not enough to stop the flow of blood if a large artery was severed.

He recalled an old method that had been discarded, that of tying off the end of a severed blood vessel with a ligature, in the way that one might wrap a bit of string around the end of a rubber tube to keep it from leaking. In 1552, at the siege of Davilliers, he tried out the ligature after amputating an officer's leg; and it worked perfectly. This method required a certain amount of skill on the part of the surgeon; Paré not only perfected the technique, but described it in such a way that others could follow his example. Gradually it replaced the use of boiling oil and hot irons to stop the flow of blood.

In this way Paré solved one of the three great problems facing the surgeon, the control of bleeding. The other two

how to prevent pain during operations and how to prevent wounds from becoming infected, were not to be solved for more than three hundred years.

This contribution, alone, was enough to entitle the humble barber-surgeon to a place among the great men of medicine. But Paré also accomplished other things. He contributed podalic version and the artificial induction of labor to obstetrics. He worked out a new, humane method of reducing dislocations, and he wrote a remarkable book on gunshot wounds. He never stopped finding ways to improve the lot of the wounded soldiers, even though money and honors were heaped upon him.

One of these honors consisted of making him a Surgeon of the Long Robe. This meant that he had to take a long examination conducted entirely in Latin! The professors gave him a passing grade although he didn't know a word of the language!

The rulers of France didn't care whether or not Paré could speak Latin. They called on him to treat them because he was the best surgeon available and because he was honest. This was very important in days when nobles and princes were constantly plotting and intriguing; kings used to consider it a good form of insurance to leave orders that their physicians were to be executed if they themselves happened to die while under the doctor's care. Paré, however, was surgeon to Henri II, François II, Charles IX, and Henri III, as well as Catherine de Medici. Though many people believed that she had poisoned her own son, François II, Paré himself was regarded as above suspicion.

His life was spared during the bloody Massacre of Saint Bartholomew, despite the fact that people were almost certain that he was a Huguenot, and everyone knew that the leading Protestant opponent of the Catholic ruling house was his patient.

Ambroise Paré was not forgotten after he died. Even today, when surgery scarcely resembles the humble craft it used to be in his time, this man, who kept his feet upon the ground, serves as an inspiration to doctors everywhere. As Paré himself put it, "The light of a candle will not diminish no matter how many may come to light their torches by it."

# 2

## *The Fabric of the Human Body*

ANDREAS VESALIUS, 1514–1564

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AFTER they had gone a short distance beyond the walls of Louvain without being detected, the two young men paused. Up to now it had been comparatively easy. They had a story ready if a watchman should challenge them: one of them had been romancing beneath his sweetheart's window while the other kept watch for her irate father. That would sound reasonable coming from two dashing university students, especially as they had a gold coin to back it up. But what excuse could they offer for skulking about outside the city walls?

They were less apt to encounter the law than they were to run across other lawbreakers — perhaps thieves and cut-throats, taking advantage of the darkness of the night. Régnier Gemma was not afraid of them. His companion, Andreas Vesalius, knowing how reckless he was, had made him promise not to get into a fight even if it meant running away. There was too much at stake to risk getting into a brawl.

However, more dangerous than the law or the lawbreakers were the dogs that prowled about, fierce creatures that fought over the bones of executed criminals dumped in a heap outside the city walls. Andreas Vesalius prayed that they would be asleep. He had studied their habits, as he had those of their French cousins whom he used to encounter last year on Montfaucon, the "dead man's hill" of Paris.

"Which way now, Vesalius?" Régnier Gemma asked.

"Left."

"I don't see how you know. It's darker than a monk's cassock. We should have brought a lantern."

"We wouldn't dare to light it," Vesalius whispered. "Besides, I know the way. Mind you keep your cloak ready to cover your face in case the moon comes out."

"Little chance of that, though there are a few breaks in the clouds."

They moved along cautiously, Vesalius in the lead. Behind them, in the circle of its four miles of walls, Louvain slept in the darkness. This old city boasted some of the most beautiful buildings in the Duchy of Brabant: the Clothworkers' Hall with its graceful pillars; and the Hôtel de Ville, whose towers were perforated to let through the light, facing the Church of Saint Pierre, which was still awaiting its spire; and, of course, the University of Louvain. It was a fine, big university, over a hundred years old — one hundred twelve to be exact, for it had been founded in 1423.

"We're nearly there," Vesalius whispered, stopping so

suddenly his friend bumped into him. "Are you sure you want to go through with it, Gemma? It's certain death if we're caught, and after all it doesn't mean anything to you. The bravest fellow in Brabant needn't risk his life for nothing."

"It isn't for nothing, it's for friendship," Gemma replied with dignity. He added with a grin which, even through the darkness, revealed a flash of teeth, "And for adventure. I wouldn't miss it for the world. Lead on, Vesalius."

A few paces farther, and Vesalius paused again. "We're just about there. We'll have to wait, now, until it gets light enough so we can see."

Not far off a dog barked sharply, stopping midway in its second bark. Dreaming, Vesalius thought, knowing the animals had fed well during the day, for there had been two executions the previous dawn. Sleep soundly, he prayed. In the chill night wind he shivered, although he was wearing the extra cloak he had brought along to use later.

It seemed like a long time before Gemma touched his arm and Vesalius, straining his eyes, saw his friend's hand pointing to the sky. A few minutes later, he could detect a rift in the clouds, a faint grayish streak in the blackness above them.

The two students waited impatiently, wondering whether there would be a break big enough to give them the necessary light.

At last a faint shimmering crack appeared in the

clouds; and then they could see a pale silvery moon behind a shroud of fast-moving shreds of mist.

*"There,"* Vesalius whispered.

High in the air, as a warning to all who might be tempted to steal, the body of a thief was hanging, swaying just a little—or was that the effect of the light? Actually, it was no longer a body, but practically a skeleton; beyond the reach of the dogs, it had provided a feast for the vultures to which it had been offered.

Vesalius restrained his friend. "No, wait till the moon is gone again," he said. "Look now, and mark what we must do, and when the darkness comes we'll do it as we planned."

Almost too soon the faint light went out again like a snuffed candle. The two young men moved forward with the precision of acrobats, found their places, went through their paces. Gemma stooped while Vesalius climbed on his shoulders; then he raised himself, boosting his companion, who went up, hand over hand.

The gibbet creaked with its double burden. Gently, with infinite care, Vesalius loosened the chains; with the skeleton in his embrace, he slid down again and deposited his burden on one of the extra cloaks Gemma had spread.

As though he had all the time in the world, Vesalius removed part of the skeleton and placed it on the second cloak, wrapping each bundle almost lovingly. Then, still with the precision of a drill, each of the students clasped his bundle close to his own body and wrapped his remaining cloak about him.

Like shadows they were gone. Now the gallows reached out empty arms; and in the darkness a dog howled miserably.

Since they bore with them the evidence of their crime, the trip back was even more dangerous than the one out had been. However, they had success for a companion now, and Vesalius knew Gemma's spirits must be soaring.

"Just keep silent until we're inside the walls again," he begged. "You know what it would mean to me if we got into a fight now and lost our precious prize."

"You can count on me; I understand," Gemma whispered back.

He was, Vesalius thought, a very prince of a fellow; but of course he did not really understand. How could he, who was a daredevil, appreciate what it was that had driven Andreas Vesalius to break the law for which he had a real respect—to risk his life and that of his friend? It was a compelling desire to learn, a hunger that had to be satisfied at any cost.

Vesalius had known that urge as long as he could remember. When he was a boy, he used to lie on his stomach for hours on the damp grass watching a frog's breathing and the contraction and thrust of its powerful thigh muscles when it jumped. At the risk of being punished by his mother, he would "borrow" a knife from her kitchen and sharpen it against a stone; then he would kill and

skin the frog, trying hard to lay those muscles bare without cutting into them.

None of his friends shared his interest. Some of them wanted to be soldiers or longed desperately to go to sea; one Flemish boy he knew was determined to paint pictures no matter what sacrifices it might mean. Another used to spend hours studying the action of a water wheel, or a windmill turning against the sky. Vesalius knew how he felt, for he, too, wanted to find out how something worked. But in Vesalius's opinion no man-made machine could compare with a living creature.

He could still recall the first time that thought had crossed his mind. His father had given him some pigs' bladders to keep him afloat while he was learning to swim, and he had blown them up and deflated them again, telling himself that all the skill of the Clothworkers' Guild could not produce a fabric so elastic as this, to be found in the body of a lowly animal. Similar thoughts had often come to him as frogs and mice had yielded him some of their secrets: a chest that acted like a bellows, sucking in and expelling air; the tiny heart beating regularly as long as life existed. The more he learned—first by himself and then in medical college—the more convinced he was that human beings could never create a machine to compare with the body, an engine consisting of not a dozen or so parts, as the casual observer might conclude, but thousands of diverse parts, thousands of different materials combining to make up its fabric. Just to understand the smallest action, such as

the motion of a finger — produced entirely by the muscles below the elbow — took hours of study. And he wanted to understand it all.

Tonight would make it possible for him to begin: now he had the bones, *all* the bones, so he could study them together. He already knew each of them so well he could identify it blindfolded, but to study them together was a different matter. It would be a real beginning at last. . . .

"Now we can talk," Gemma said, and Vesalius realized that they were inside the city walls again. "In fact we're less apt to arouse suspicion that way, if we should run into a watchman. Not that anybody would suspect a couple of fellows who look as substantial as we do now. We bulge like prosperous burgomasters," and he patted the bundle beneath his cloak. "A good night's work, Vesalius. I'd give a lot to see our friends' faces if they knew what we'd been up to — though I won't tell them, I promise you."

"You'd probably end up tied to a stake if you did. Save it to tell your grandchildren, though I'm sure you'll have even better adventures to regale them with. But I'll certainly tell mine about it, and how you risked your life to do a favor for a friend."

"Nonsense, I told you I wouldn't have missed it for anything. It'll be reward enough for me to hear you tell the professors that you had this skeleton sent to you from Paris. How they'll envy you the fine friends you must have made there, to send you such a priceless gift. Not that I don't envy you myself. I'd give a lot to see Paris;

and my father would have sent me, too, if another war hadn't come along — curse the king of France!"

Vesalius didn't have any sympathy for King François of France either. Andreas Vesalius was Flemish; the name Vesalius was taken from Wesel, the birthplace of his family. He himself, however, had been born in Brussels while his father was serving as apothecary to Margaret of Brabant. This was the year in which François I had ascended the throne of France — or perhaps the year before, since no one was quite certain whether Andreas Vesalius had arrived before or after midnight, on New Year's Eve or New Year's Day of 1514 or 1515.

"In some ways you've got to admire King François," Gemma went on. "He's been fighting and losing as long as I can remember, and nothing seems to stop him."

"Not even his own royal signature on a treaty," Vesalius pointed out. "But for that, France would be at peace and I would still be studying medicine in Paris. But for the war, I would be in the medical center of the world, instead of here in Louvain, where not a single demonstration of anatomy has taken place in over fifteen years."

The two walked in silence for a time, while Vesalius continued to think of Paris. Even there he had felt that the teaching of anatomy left a great deal to be desired. The head of the medical faculty of the College of France was Jacques Dubois (who preferred to be called by the Latinized version of his name, Jacobus Sylvius). Vesalius didn't think he had any conception of the importance of studying the human body. Like most physicians, Syl-

vius considered it beneath his dignity to touch a scalpel, agreeing that such work should be performed by "*chirurgiens*" (surgeons), a word which means those who work with their hands.

In the main, Sylvius's teaching consisted of sitting before a table on which a pile of dogs' viscera had been placed, and reading aloud from Galen. Usually he skipped as much as he read, for he considered whole sections of Galen too complicated for the students to understand; this, in Vesalius's opinion, was adding insult to injury.

On the important occasions when a human body was publicly dissected, Sylvius would sit high up on his professorial chair, cackling like a jackdaw while an ignorant barber-surgeon wielded the scalpel and a demonstrator pointed with his stick. Most of the spectators didn't even notice when Sylvius was reading one thing and the pointer clearly indicated something different. He would call their attention to the fact that the liver had several lobes, while the pointer would hover above a liver that belied his words.

If anyone mentioned this to Sylvius he would answer impatiently that it was obvious the human body must have changed since Galen's day. No one would dream of doubting Galen, the Greek who had become the greatest physician of Rome and of the world. He had systematized the existing theories and added a few of his own; from that time on, over 1300 years ago, the Western world had agreed that to study medicine one need only to study Galen; to know Galen was to know medicine.

Without questioning Galen's authority, Vesalius, however, thought that Sylvius ought to have spent a little time discussing the human body as it appeared on the dissecting table in the 1530's instead of limiting himself to describing it as it used to be when Galen wrote about it. Yet Vesalius would be eternally grateful to Sylvius for giving him the greatest experience of his life. Impressed with the young student's knowledge of anatomy, Sylvius had chosen him to perform a public demonstration. Vesalius never dared to describe his sensations when, for the first time, he delved into the mystery of the human body. People would have said he was being sacrilegious if he had tried to tell them how much it meant to him; and he knew the authorities eyed him with some suspicion anyway because of his interest in anatomy. He could not see why it should be sacrilegious for him to be "too enthusiastic" about dissecting when it had been sanctioned by the Church and legalized by most states before he had been born.

In Italy, he had heard, people were not accused of failing to appreciate the importance of the soul just because they were interested in the body. Italy was the birthplace of the new scientific spirit, the land where the arts were held in such esteem that even nobles no longer regarded painters and sculptors as menials because they worked with their hands. The fame of artists like Leonardo da Vinci and Michelangelo Buonarroti had reached as far north as the Netherlands; and Vesalius had heard that they knew more about the human body than did most physicians. A student in Paris had told him (confiden-

tially, for it was dangerous to speak in so irreverent a fashion) that one could learn more about the muscles from Michelangelo's figures in the Sistine Chapel than from an atlas of anatomy. Vesalius had made up his mind that he was going to go to Italy.

The sound of his friend's voice cut in upon his thoughts and brought him back to Louvain. "Slow up, Vesalius," Gemma was complaining good-naturedly. "I know you are in a hurry, but you needn't run me off my feet."

Vesalius apologized sheepishly. "I'm sorry. I guess I'm getting impatient to get home and look over our prize. I'm a little worried about whether any of the extremities are missing, although the tendons seemed to be holding pretty well."

"I'm sure our friend will get along even if he's missing a few toes. You're not thinking of going back to look for them, are you?"

"Let's cross that bridge when we get to it," Vesalius answered. As they reached his street, he continued, "Shall we separate here? I can manage both bundles."

"I'll help you get them through the window. A few minutes more or less won't make any difference to me because I'm going to sleep all morning anyway." Gemma yawned. "I mean sleep in my bed, not on those hard seats in the amphitheater. If anyone asks about me, tell 'em I was up late devoting myself to anatomy."

"I will, and it'll be the truth. I won't even try to thank you, but some day I may be able to show you how much

you've done for me." To himself, Andreas Vesalius added, "And, through me, for the study of the fabric of the human body."

A few years later, a most important medical project was undertaken in Italy: a new edition of Galen's works. Leading physicians were called upon to edit the various sections. The logical choice for editor of the section on anatomy was Professor Andreas Vesalius. No one knew more about the human body than did this young man who had gone to Italy and had been made a professor at Padua before he was twenty-three.

One of the most important parts of Vesalius's editorial work was the preparation of specimens for an artist to use in illustrating the text. Over and over again Vesalius noticed how different the things Galen described were from those he was dissecting. He had seen plenty of bones and organs like the ones Galen wrote about, but only in dogs and goats and other animals.

Suddenly a suspicion awakened in him; he examined it thoroughly before he voiced it even to himself; he checked and verified it until there could be no doubt. Galen had dissected and described *animals,* not humans. For centuries physicians, forbidden to dissect the human body, had studied and taught Galen under the impression that they were studying and teaching human anatomy. It was doubtful whether or not Galen had ever performed a dissection of the human body.

Unless doctors learned anatomy — human anatomy, not

that of animals — there could be no advance in medicine and surgery. Vesalius would not even consider perpetuating any longer the mistakes of Galen. Instead of editing his works, he would write a brand-new book, the first real textbook of human anatomy.

The authority of Galen, which few had dared to challenge, was now overthrown, and medicine was free to move forward after its long period of stagnation when, at the age of twenty-seven, Andreas Vesalius gave to the world his *De Humani Corporis Fabrica.*

# 3

## *The Barrel and the Beam*

LEOPOLD AUENBRUGGER, 1722–1809

RENÉ THÉOPHILE
HYACINTHE LAËNNEC, 1781–1826

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HUMMING a cheerful melody, Herr Doktor Leopold Auenbrugger prepared to go to work in the hospital, as contented a man as could be found anywhere in the year of 1754. He had everything he had ever wished for — more, indeed, than he had even dreamed of when he had arrived in Vienna, a dozen years ago, to study medicine. Going to a university was a rare privilege for the son of an Austrian innkeeper, even one whose establishment was run well and profitably, like the inn At the Sign of the Three Black Moorish Women; but Auenbrugger senior had willingly provided the money.

The young man's record at the university had not been a brilliant one, but this was quite all right with both Auenbruggers, who ranked thoroughness above brilliance; for Leopold had been regarded as a sound, diligent student. His reward was the degree which made him a

member of a worthy and respected profession, entitling him to be addressed as Herr Doktor. Next came a position as assistant physician, and now he was physician in chief at the Hospital of the Holy Trinity, known also as the Spanish Hospital.

The doctors at this hospital were teachers, like most physicians who held hospital positions, but they were not a part of the faculty of the University of Vienna. Auenbrugger had a tremendous respect for that institution, which was making Vienna the world's leading medical center — thanks to Gerhard van Swieten, under whom he had studied. Yet much as he admired the university, Leopold Auenbrugger did not waste any time regretting the fact that he was not one of its professors. He was altogether too contented with his own position in the hospital and with his newly acquired status as a married man.

How glad he was he had not succumbed to any of the pretty girls who had caught his eye when he was a student! It was worth waiting until one was a mature man of thirty-two in order to win a prize like his Mariana von Priestersberg, a fine figure of a woman he would have been proud to marry even if she didn't have a penny. But she did, for she came from a fine family, a well-to-do one with a "von" before its name. In spite of that she looked up to him as a good wife should. She also shared his interest in music, and she made him comfortable. How she made him comfortable! It was a credit to Leopold Auenbrugger (though the thought never crossed his mind) that he was not tempted to neglect his work and spend

more time at home with his Mariana, her wonderful food, and the comic operas he delighted in writing.

However, Auenbrugger loved his work, for it was a part of living, and he enjoyed everything about life. Now, as he paused at the bed of a patient, he found himself hoping he could restore this man to health so that he, too, could enjoy life — a good stein of beer after the day's labors, a picnic with his children.

This patient was suffering from a chest ailment which Auenbrugger believed to be an empyema — a diagnosis which seemed obvious. That morning, conducting his students through the ward, he had asked their opinion, and each of them had said without hesitation, "An empyema."

"Describe the condition, and state the procedure to be followed," he had ordered one of them.

"An empyema is an accumulation of pus in the chest cavity, for which paracentesis must be performed. This means, to puncture the chest wall with a trocar and draw off the fluid."

"Correct. I shall attend to it this afternoon. Let us proceed to the next patient."

Now that it was afternoon, the shadow of a doubt crossed Auenbrugger's mind. How often had he, and other physicians, diagnosed an empyema, only to find no fluid present when he inserted his surgical instrument. Could he be mistaken this time? The man lying before him in a deep feverish sleep was very ill. Yet Auenbrugger hesitated to send for his assistant and perform what might be an unnecessary operation, even though neglect-

ing to draw off the pus might cause the patient's death. How could he decide?

If only, he thought, there were some way short of an autopsy of discovering what was inside a patient's chest. It was different with ailments of the abdominal region; there one could palpate, exploring with hands trained to detect any abnormality; but no one could feel inside the rigid bony box of the thorax, which housed the heart and lungs.

No wonder doctors were so frequently mistaken in diagnosing empyemas, when all they had to go by was the patient's condition and his symptoms which he, like this man, was often too sick or confused to describe accurately. Once in a while a patient would report that he felt the fluid in his chest, that he could actually feel it sloshing about when he walked; and then one could be certain of relieving his condition by drawing it off with a trocar. If only there were some way . . . Auenbrugger shook his head; no one could hope to see or feel what was inside this man's strong, barrel-shaped chest.

Then, suddenly, Leopold Auenbrugger imagined he was back home again, helping his father take stock of their beer and wine supply. "We must bring in some more red wine," his father was saying, tapping against the barrel with his fingers. "There's not much left, the wine is down to here."

Leopold, too, had known exactly how much wine remained in the barrel, his quick ear distinguishing the difference in the sounds made by his father's fingers. Tap-

ping against a barrel with wine in it made a high, flat sound; when one tapped over a portion filled with air, the sound was lower and clearer. By listening for the difference in tone and resonance, one could tell the spot where the wine ended and the air began as precisely as though one could look inside. His mother used to do practically the same thing: when she wanted to know whether a scullery maid had damaged one of her bowls, she would tap it and hold it to her ear, determining by its ring whether or not it had a crack in it. If one's ear could tell what was inside a barrel or a pot . . .

For a long time Leopold Auenbrugger stood looking down at the unconscious form on the bed before him, his large, pleasant face impassive. Then, almost of their own accord, his fingers strummed on the patient's body. There was a faraway and yet intense look in his eyes, and his head was cocked to one side like that of a musician tuning his kettledrums in the noisy pit of an orchestra. Only this was an instrument which had never been played before.

He was not yet able to interpret what it meant, but there was no doubt about the fact that his fingers, thumping on the patient's chest, brought forth a sound like that made by a muffled drum.

Half a dozen years later, half a dozen years of painstaking, thorough work on the living and the dead, and Auenbrugger's book was ready. He gave it a long but accurate title: *A New Discovery in Order by Percussion of*

*the Human Thorax, to Discover Signs for the Recognition of Hidden Diseases of the Chest.* It was written simply and precisely, beginning with:

I. The thorax of a healthy person sounds, when struck.

II. The sound thus elicited from the healthy chest resembles the stifled sound of a drum covered with a thick woolen cloth or other envelope. . . .

And so on, stating exactly what sounds one would hear by tapping the normal and the abnormal chest. When it came to describing the tone given by a lung containing cavities, he knew there was no better phrase than the one his mother would have used: "a cracked-pot resonance."

His descriptions were excellent, but they weren't much good to a doctor unless he had a musician's ear and the patience to do a good deal of practice thumping. Leopold Auenbrugger was not a man to force his method on people, even his own students. He was pleased because he had found an aid in diagnosing lung and heart ailments, and because his book sold well even though most of the leading physicians considered percussion, or thumping, a waste of time and refused to let their patients be subjected to it.

Leopold Auenbrugger was also pleased because he had a wife who continued to be everything a man could want, two lovely daughters and, eventually, a patent of nobility from the emperor. That was a great deal for the son of an innkeeper to receive because he had worked

hard, had a good ear, and imagination enough to realize that the thorax of a person, when struck, gives off certain sounds.

It was not, however, enough to put over the method of percussion. It might never have caught on but for Maximilian Stoll, chief of the Vienna clinic, who realized its value; and a young doctor named Jean Nicolas Corvisart who, dissatisfied with the backwardness of clinical medicine in France, went to Vienna to study.

Percussion appealed to Corvisart. His powers of observation were as keen and as well trained as those of any detective, with the disease taking the place of the criminal and the patient's body the scene of the crime. Eventually he became so good that he once glanced at a portrait and remarked, "If this picture is a faithful one, the subject must have died of heart disease"—and he was right.

In Vienna, Corvisart studied percussion under Stoll and decided it would be an invaluable aid in diagnosis. The French translation of Auenbrugger's book was a poor one, and so Corvisart made another, adding notes and comments of his own (all of which were excellent) until the book was four times its original size. Most of Corvisart's colleagues would have brought it out as an original work, with a line of acknowledgment to Auenbrugger, but Corvisart wasn't that kind of man. As Napoleon, who made him his physician, remarked, he was honest—and blunt and obstinate. When he was young, Corvisart had won a position at the Necker Hospital, but he never filled it because the hospital insisted its

physicians must wear wigs, and Corvisart refused to comply with such a foolish regulation.

By 1797, the year he completed his translation of Auenbrugger's book, he had been appointed (wig or no wig) professor of medicine at the College of France, was recognized everywhere as one of the world's great teachers and clinicians. In the first years of the new century, he had among his pupils a lad named René Théophile Hyacinthe Laënnec, scarcely five feet three inches tall and so thin, as he himself used to put it, that he didn't even cast a shadow. His face looked emaciated, his complexion was poor; but he had a brilliant mind and he loved medicine.

René had begun studying to be a doctor when he was not yet fifteen, under the direction of his uncle, who was as good a physician as could be found in a city the size of Nantes. The uncle had brought René up, for his mother had died when he was only six, and although his father had married a well-to-do widow, he never got around to taking care of his children. He spent most of his time writing bad poetry and his money in having it printed. Although he never refused to help his sons, René and Michaud, he just couldn't seem to manage to keep his promises.

René's father heartily agreed with his uncle that the boy, having learned all he could in Nantes, should go to Paris to study at the École de Médecine. But that took money, and several years passed before he sent the first installment. Naturally, he didn't keep up his remittances.

When he did write, his letters were far less apt to contain cash than a request to his son to put in a good word for him and his poetry: couldn't René speak to some of the important people, Corvisart perhaps, whom he must know now that he was distinguishing himself by winning prizes? René would reply politely to his father's embarrassing requests, his long upper lip curling in a rueful smile as he explained that M. Corvisart scarcely recognized him when he saw him, and as for the prize money, it had gone to pay back debts, so he hoped his father would be able to do something about this term's tuition.

René managed to get along with very little money. He roomed with his brother, Michaud, who was a year younger than he, and his three great pleasures in life were not expensive: taking walks, playing the flute, and working.

He did well. By the time he was twenty-five he was teaching, and editing a medical journal, which kept him perfectly happy for four years, until, in 1810, his brother, Michaud, died of tuberculosis. This disease, which was then called consumption, was one in which René had always been interested, partly because some people thought his mother had died of it, and partly because it was a particularly dreadful one, taking so many people in the prime of their lives. As a student, he had done excellent research in the pathology of *phthisis* (the Greek word for consumption). He was convinced that hemorrhages were the result and not the cause of consumption

of the lungs. Noticing that few sailors suffered from the disease, he thought sea air would be beneficial to its victims.

Having a musician's ear, René became skilled in the art of percussion, which helped him to detect diseases of the chest, including heart ailments as well as those of the lungs. Another method he had been taught to employ was auscultation (listening to chest sounds by placing his ear against the patient's body). For centuries doctors had realized that certain sounds were associated with certain illnesses: for example, the breathing of a person with bronchitis made a whistling noise. Since Auenbrugger had shown that one could use one's ears to "see" inside the human chest, doctors like Corvisart employed auscultation as well as percussion to diagnose diseases of the heart and lungs.

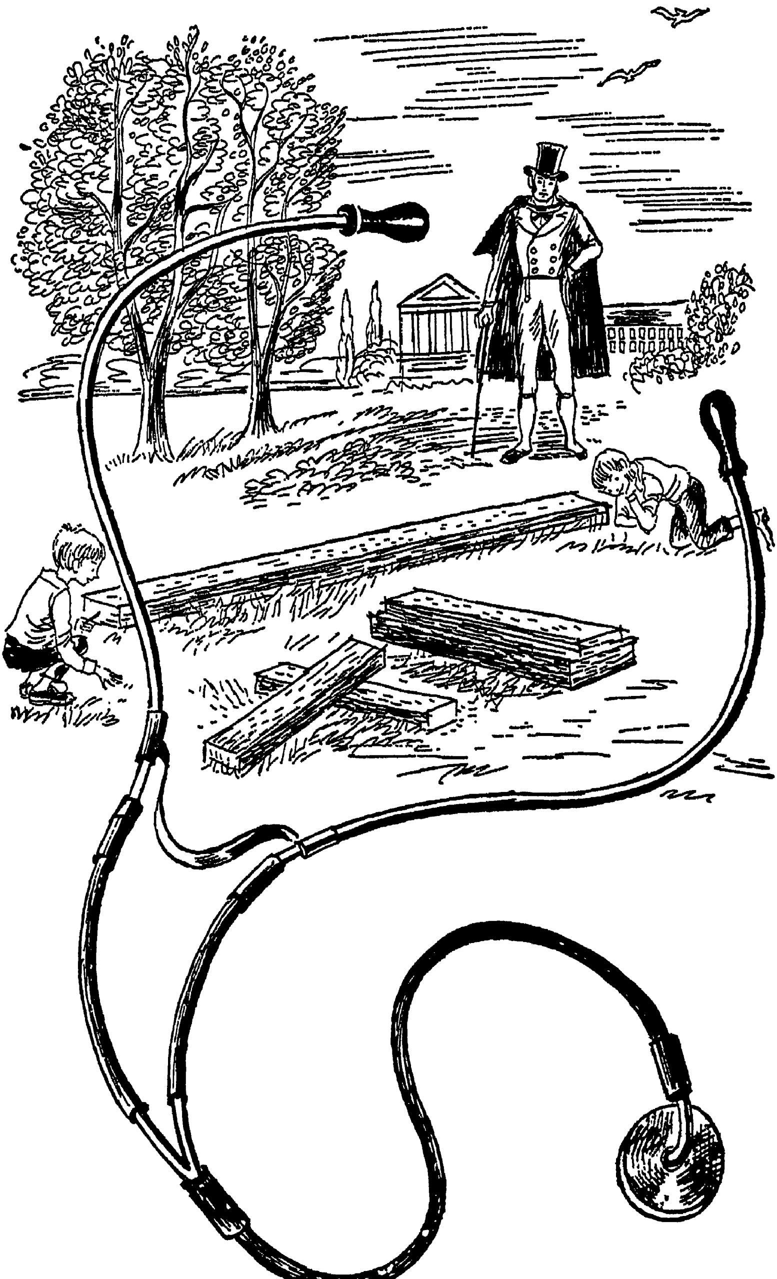
Unfortunately auscultation had limitations. Obese people frequently suffered from heart diseases, and it was practically impossible to hear anything through thick layers of fat. Many patients were so dirty that even René Laënnec's ardor was dampened by the thought of the fleas lying in wait for him on their chests. Male patients were often so hairy all he could distinguish was a lot of crackling sounds, while the modesty of female patients was outraged if a physician put his ear against their bosoms. Some doctors managed to override their objections, but Laënnec soon gave up trying because he always became so embarrassed himself that his face flushed and he

couldn't hear anything except the roaring of his own blood in his ears.

Even now, when he was a man of almost thirty-five with an important position at the Necker Hospital, he felt himself blushing at the thought of the young lady whom he was going to examine. She was extremely modest, but she was also so fat it wouldn't do any good if he could bring himself to urge her to let him listen to her heart. He sighed, for unless he could hear it beating, he would not be able to tell how serious her condition was.

It was a fine day, and Laënnec, who had not been feeling very well, decided it would do him good to take a walk before going to the hospital. His spirits rose as he walked along under the horse-chestnut trees, slowing down for an instant to enjoy the smell of the overblown roses an old woman was offering for sale, and pausing again to watch some children marching sedately along, double file, hand in hand. He loved the streets of Paris even though they could not compare with those of Quimper where he had been born. He smiled a little, thinking of one of the walks he had taken as a boy—it had turned out to be more than enough even for him, the best part of thirty miles, from Nantes to Quimper—because his father had written him to come home on a visit and he had eventually grown tired of waiting for the fare to arrive.

In the courtyard of the Louvre he paused, frowning at a pile of debris a workman had evidently neglected to



take away after making some repairs. He had to admit that, unsightly though it was, it was giving a group of children a lot of pleasure. They were intently playing with whatever it was their imagination had created from the slats and boards. What could those youngsters be up to, he wondered, noticing a boy lying on the ground beside one end of a beam while another boy crouched at its other end? He moved over cautiously. The crouching boy was scratching the end of the beam with a nail, tapping and scratching alternately; the boy whose face was pressed against the other end was calling out, "There — I hear it. I hear."

"Now it's my turn," his companion said. "I'll listen while you do the signaling."

Laënnec stood motionless for only an instant. Then, as fast as he could, he hurried to the hospital, upstairs to the room of his fat, modest patient. Standing there panting a little, he rolled up tightly, tightly, the paper in his hand — a booklet he had picked up because he didn't want to take the time to look for a piece of wood. He *had* to try out, immediately, the principle he would never have thought of if he had not seen two youngsters making a game of it — the principle that sound is conducted by certain materials such as wood.

He tied a bit of string about the quire of paper he had rolled up, not quite satisfied with it because he had been unable to roll it tightly enough to obliterate the air space in its center. But perhaps it would do.

"Please be so kind, madam," he said, "as to place this

end of the cylinder directly over your heart while I apply my ear to the other end." He averted his face tactfully while she adjusted the bedclothes.

There was no need to ask her whether she had complied with his request. Through the roll of paper, through the layers of fat, there came to his ears, clearer and more distinct than he had ever heard it before, the thump, thump, thump of a beating heart.

For three years frail little René Théophile Hyacinthe Laënnec worked as hard as husky Leopold Auenbrugger had ever worked, to perfect his method. He called it mediate auscultation (listening with the aid of an intermediate object). His instrument he usually called a "cylinder" or a "baton," although he invented the word "stethoscope" to describe it scientifically. He tried various sizes and shapes, discovering that the air space in the center was an advantage rather than a disadvantage, and always making his batons a little longer than the distance a flea could jump.

In 1819 he published his big two-volume book; and then his health broke down. After two years in Brittany, he felt well enough to return to Paris and the excellent position waiting for him. Four years later, in 1826, he had to quit work again, this time taking his housekeeper, whom he had married, to Brittany with him. But instead of getting better, he soon died of consumption, the disease which had taken his brother, and which his stethoscope would have enabled physicians to detect.

The value of mediate auscultation, like that of percussion, was at that time appreciated by only the most alert physicians, but gradually it caught on. And even today, when the miracle of the X ray makes it possible to see inside the chest, physicians still thump, and still use the stethoscope, exactly as they were advised to do by two doctors who grasped the clues provided by a barrel and a beam.

# 4

## *Taming the Pox*

EDWARD JENNER, 1749–1823

UNTIL less than a century and a half ago, scarred and pitted faces were the rule, and unblemished complexions the exception. Anyone who had no disfiguring pockmarks was greatly admired, but those who had had smallpox and had come through unscarred were truly envied. The others still had the disease hanging over them, which was very much like living with a bomb that might go off at any time. "Pox take you!" was one of the worst things a person could wish his enemy; and mothers felt superstitious about even counting their children until they had survived the smallpox. During severe epidemics smallpox could wipe out whole families, or leave the majority of its victims disfigured or blind.

Sometimes, however, smallpox would appear in a comparatively mild form, and people who caught it then were very fortunate, for no one ever had it a second time. Everywhere people prayed for a mild case of variola, which was the disease's technical name. In some coun-

tries they did more than pray. They deliberately exposed themselves or their children if they found someone who had a "good" case of smallpox.

In the Orient, doctors worked out methods of giving the disease, under proper circumstances, to people who could afford it, and as a means of insuring the value of slaves, particularly girls, who commanded a high price if their beauty could be guaranteed.

Smallpox was known to be a contagious disease, one which was transmitted from one person to another, or through an intermediary object such as infected clothing —in some cases, doctors said, by the air. Oriental physicians employed the easiest way to transmit smallpox, using material from the sores that characterized the disease. It did not take them long to discover that when they happened to use old, dried material, the cases were less severe than when they used material that was fresh.

While Lady Mary Wortley Montagu was in Constantinople with her husband, the British ambassador, she learned of this practice and, being a great letter writer, told her friends about it. "The small-pox, so fatal and general amongst us," she wrote, "is here rendered entirely harmless by the invention of ingrafting which is the term they give it. . . . The old woman comes with a nutshell full of the matter of the best sort of small-pox . . . and puts into the vein as much venom as can lie upon the head of her needle, and after binds up the little wound in a hollow bit of shell. There is no example of anyone that has died of it . . . I intend to try it on my dear lit-

tle son." Lady Mary's friends included members of the nobility who were greatly impressed when she wrote them of her successful experiment. When she returned to England in 1718, she persuaded the Princess of Wales to try the method on her own children—after testing it on some "unimportant" ones first.

Inspired by this example, others followed suit, and "variolation"—as it was then called—became popular. In America Dr. Zabdiel Boylston took it up. He was delighted when his results were even better than those of the British doctors: two hundred thirty-five recoveries and only six deaths. He could not understand the violent opposition to variolation.

Some of the opposition was unwarranted, but some was justified. Variolation did cut down on the mortality from smallpox, but it was by no means safe. Sometimes in the process patients would come down with blood poisoning or other diseases in addition to the pox; and on occasions the disease would cease to be mild, and a dangerous epidemic might result, especially among poor people who, since they could not afford to go to an expensive sanitarium to "enjoy" the pox, often gave it to their neighbors.

Twenty-four-year-old Edward Jenner practiced variolation when he returned to Gloucestershire after completing his medical training under the great British surgeon John Hunter. Jenner was delighted to be back home again in the country which, in comparison with London and its grim hospitals, seemed even greener and lovelier

than he remembered it. He was struck by the fact that there were more pretty girls than in the city: the dairymaids in particular really did live up to their reputations for lovely complexions. Looking at them, he recalled the old wives' tale to the effect that people who worked with cattle were seldom disfigured by the smallpox, and he began to wonder whether or not it could be more than just an old wives' tale.

One day Jenner inoculated the family and the servants of the Earl of Berkeley; and the gardener, Joseph Merrit, failed to come down with the smallpox, although he had never had the disease, so far as he or his family knew. Then he remembered that he had once had a few sores that resembled those of the smallpox; they had broken out on his hands after he had been milking a cow with sores on her udder.

Several times after that, a cowherd or a milkmaid would fail to respond to Jenner's variolation, and almost always there was some story about a cow with sores. People who'd had sores on their hands didn't get smallpox, a woman informed him as casually as she would have remarked that milk turned sour during a thunderstorm; she had nursed her baby when it had smallpox without being a bit worried about catching the disease.

Jenner couldn't dismiss these stories as groundless superstition; being a true disciple of Hunter, he went into the matter thoroughly. By the time he had finished his investigations, he was convinced that there was something to it; he could find no one who had caught the

sores from tending sick cattle and had later had the smallpox. The diseases must be similar, he reasoned, calling the one from which the cattle suffered "cowpox." If cowpox kept people from getting smallpox, why couldn't he give it to them deliberately and make them just as immune as though he had practiced variolation upon them? Cowpox was a harmless disease. He told his idea to Hunter, and Hunter's advice was, "Do not think, *try*." Characteristically, he added, "Be patient and be accurate." The time had come to experiment.

The cows on the farm where eight-year-old James Phipps lived came down with sore udders, and — not at all surprisingly — Sarah Nelmes, the milkmaid, got some sores on her hand. The boy's parents agreed to let Dr. Jenner inoculate James with material from one of Sarah's sores; they were going to have James given the smallpox anyway, and they could see no harm in his having what Dr. Jenner called cowpox first; it might help the boy to get off with a very light case of variola.

James was not worried when they told him he was going to be "given" some sores like the three on Sarah's hand, for she had assured him that they didn't hurt. He was, however, indignant when the doctor scratched his arm twice with a sharp instrument. Yet it did not hurt very long, and he rather liked the fuss the doctor made over him, visiting him every day even though he wasn't sick — except, just a little, on the eighth day after the scratching, when he didn't feel at all like playing.

Six weeks after the first inoculation, which had taken

place on May 14, 1796, the doctor announced that he was going to scratch James's arm again. This time the boy had to be held, for he had heard his parents talking about "smallpox," and that was a frightening word.

"I don't want the smallpox, I don't, I don't!" he cried.

"I hope and pray that you won't get it, lad," said Jenner.

"Then why are you doing this to me?" the boy asked, looking up at the doctor's full, pleasant face.

Jenner tried to put it into words James would understand. "So that nobody will have to get the smallpox any more, nobody will have to get very sick from it and perhaps even die. They'll just have to have their arms scratched, and then they'll be all right."

"All the other children will have their arms scratched, too?"

"Children and grownups. But you'll be the first, and I'll tell them all what a good, brave lad you were," said Jenner, adding to himself—"*if* I'm right, and he doesn't get the smallpox." For this time it was material from a smallpox sore that Jenner bandaged over the scratch on James's arm.

Anxiously he waited, examining the boy closely for signs of a smallpox blister or any trace of fever, watching closely until long after the time when James should have had his attack. Yet even then Jenner wasn't absolutely certain, for there was a chance that the material he had used in his variolation had been too old and weak. With a scientific thoroughness that the boy was the last to ap-

preciate, Jenner inoculated James again before the end of the summer. This time when nothing happened, he was certain that inoculation with cowpox provided immunity against smallpox.

The Royal Society was not particularly impressed with the report of this case which Jenner sent in; so for two more years he repeated the experiment. Only by now the people of Gloucestershire no longer considered it an experiment, but an easy way to be protected against smallpox. In 1798 he published a pamphlet describing twenty-three successful inoculations with cowpox; the next year and the year after that, more pamphlets about additional cases. By this time other doctors were trying his method, which he called "vaccination" because he used material from a cow, or *vacca.*

Vaccination met with opposition by those who were certain God would not approve of it. In those days people were inclined to see sacrilege not only in medical discoveries, but in anything new. (The winnowing machine met with objections on the grounds that only God should have the power to raise the winds.) Vaccination struck them as particularly evil since it consisted of giving human beings a disease which God had intended for cattle; some doctors "proved" this point by citing cases of children who grew horns after being vaccinated, and the caricaturist Rowlandson carried this idea further with an amusing picture of a doctor's office filled with victims who were growing udders all over their bodies.

However, the fear of smallpox was great enough to

overcome these objections. Vaccination spread rapidly to Austria and Switzerland and the United States where, as early as 1799, Dr. Benjamin Waterhouse of Harvard tried it on his family, having to send to England for a thread impregnated with cowpox, since he couldn't find any American cattle having that disease. In 1802, only six years after Jenner had vaccinated James Phipps, the British government voted Edward Jenner ten thousand pounds with more to follow.

One of the most dreadful diseases in history was being wiped out; yet no one, not even Jenner, knew how or why vaccination worked. He had noticed that something happened—that people who got cowpox did not get smallpox. He had tested and experimented and proved that this was so; and had worked out a method so that physicians could do deliberately and on a large scale what nature had previously done on a small and haphazard one. As Jenner wrote in his booklet, wording it in such a way as to make his discovery acceptable, man had tamed a great number of animals: "The Wolf, disarmed of ferocity, is now pillowed in the lady's lap. The Cat, the little Tiger of our island, whose natural home is in the forest, is equally domesticated and caressed." What he had done was to domesticate smallpox and render it harmless. It was the greatest accomplishment of any doctor in those days at the end of the eighteenth century.

# 5

## *Thank You for the Sky*

### PHILIPPE PINEL, 1755–1826

In the opinion of Pussin, chief attendant at the Asylum of Bicêtre, the event that would take place that day was of the utmost importance. If it went well, things would be different at the Bicêtre—better for him, and far better for the madmen who were incarcerated there. Dr. Philippe Pinel, the superintendent, said that this would mark the inauguration of a new era for lunatics everywhere, since the entire world was influenced by what happened in Paris. It was what Dr. Pinel had been working for during the past two years— "Without assistance from anyone," Pussin thought proudly, "except me."

Pussin had seen eye to eye with the little doctor from the very day, in 1792, that M. Pinel had received the appointment. (Pussin always addressed the doctor as Citizen Pinel, but he found it more natural to think of him as Monsieur.) The other attendants, Pussin knew, had not been impressed by the new physician in chief, who was small and slight and unassuming; besides, they felt

that any doctor who would accept a position in a madhouse when he was over thirty-five years old couldn't amount to much. Pussin knew they were speaking for themselves. Many of them were ex-convicts, and the rest too depraved or too lazy to get or hold other jobs. He himself, however, could have found plenty of positions, but he stayed at the Bicêtre because he considered one place very much like another, work being work under any circumstances.

The doctor, Pussin discovered, actually *wanted* to work among the insane. Pussin wondered about that, but, as the doctor was very reticent, it was some time before he discovered how his interest had been awakened; one of M. Pinel's friends had gone mad and, being badly treated, had run away into the forest where the wolves had eaten him up.

Pinel insisted that lunatics should not be treated with brutality. He felt that humane methods, such as persuasion, were more effective. Pussin had always felt that way. Brutality was a two-edged sword, for many madmen had good memories and were cunning enough to dissemble until an attendant was off guard, at which point they would take a terrible revenge. More than one of the guards at the Bicêtre had been killed by a blow from some powerful maniac he had mistreated. Pussin always handled the lunatics as though they were children, while remembering that they were not children and that he must be ready to use the wits which the good Lord had given him. It also seemed obvious to him that, since one spent

all day in the asylum, it would be pleasanter if the filthy cells could be cleaned up, which was impossible as long as the attendants were afraid to go near the lunatics who were chained to the walls.

Pussin regretted the fact that the other guards did not feel the way he did, but he did not think there was anything he could do about that. It was probably in their natures to be cruel, he reasoned, for everyone is as he is and behaves accordingly. But Philippe Pinel did not reason that way. He was determined to bring about a change.

Pussin did not understand many of the arguments that the doctor advanced, for M. Pinel was a savant and he himself only an uneducated man. The doctor, for example, was engaged in making a new classification of types of insanity, along the lines, he explained, of his work on diseases, which he called by the impressive title *Nosographie Philosophique, ou la méthode de l'analyse appliquée à la médecine.* It was all the same to Pussin if M. Pinel wanted to spend his time on such matters; for himself, he was satisfied with the present classification: the restless and dangerous lunatics were called maniacs, those who were always sad were the melancholiacs, and those who were confused were suffering from dementia.

He did, however, understand what M. Pinel said was the basic idea underlying everything he wanted to do: the idea that the insane were not inhuman monsters, but sick people, and that they should be treated like patients rather than like vicious animals devoid of all feeling.

While Pinel admitted that this was contrary to existing

medical and philosophical theories, he offered a number of arguments to support his theory. Although madness was said to be caused by the destruction of certain portions of the brain, without which no man was human, Pinel did not believe this to be true; most of the postmortems performed on the brains of inmates who had died after years of insanity showed no trace of a lesion. Then, too, certain of the lunatics had long periods during which they behaved normally, and this, Pinel said, proved that nothing essential in their brains had been destroyed. He thought they were suffering from a seasonal malady and were not, as most doctors believed, possessed by demons craftily pretending to be human. Pussin was inclined to agree with him, having noticed that certain of the inmates were affected regularly at the same time each year; Pussin wondered whether the atmospheric conditions might make their blood thicken and clog up their brains.

Regardless of theories, Pussin was sure good common sense and humanity were on the side of Philippe Pinel. He was all in favor of the doctor's attempts to improve conditions at the Bicêtre, even when the doctor demanded more and better food for the inmates; the authorities had always acted on the premises that lunatics were easier to handle if they were not well-fed and strong, and that they didn't know what they were eating anyway. Still more radical, M. Pinel wanted to have some of them released from their chains and put to work making a gar-

den on the grounds — claiming such labor would do them good.

Shy and retiring as Philippe Pinel was (he had once told Pussin he used to do badly at examinations because they made him so nervous), he went before the Convention and argued that the benefits of the Revolution should apply to lunatics, that the rights of man ought to be extended even to them. Pussin was surprised to find himself admiring such foolhardiness. It was only prudent not to attract attention to oneself during times like these, when the guillotine was almost never idle — especially if, like the doctor, one was under suspicion anyway. Not that Pinel was an aristocrat by birth, or had sided with their cause; but it was rumored that he had helped people to escape the Terror. Pussin preferred not even to wonder whether the doctor had indeed cheated the guillotine of its prey.

Suspect that he was, Pinel had deliberately tackled so formidable a trio as the Warders of Paris: Robespierre, Saint-Just, and Couthon, the very fathers of the Terror, asking their permission to remove the chains from fifty lunatics and give them the freedom of the grounds. The Warders naturally wondered whether this was a plot to turn loose the beasts and terrorize the city, or to free some enemies of the people Pinel was concealing among the inmates.

When Pinel persisted, Couthon agreed to go to the Bicêtre and look things over — probably because he wanted

to find out whether anything illicit was going on. All the guards (including Pussin himself) dreaded the visit of Couthon, the nod of whose head could send one to the guillotine. Afterward Pussin had to smile when he remembered how Couthon, pressing against the bars in an effort to see into a dark cell, found himself staring directly into the eyes of a maniac who burst into shrieks of laughter. Couthon recoiled in fright, and the guards quickly looked the other way, since it was never prudent to witness the embarrassment of anyone in authority. Despite his fear, Couthon made a complete round of inspection, a lengthy process since he was a cripple and walked slowly. Evidently he convinced himself that no counterrevolutionaries were hidden among the lunatics. Then he turned to Pinel:

"Have you gone out of your mind that you want to turn loose these beasts?" he asked. As though to emphasize his words, there echoed through the courtyard a particularly ferocious shriek, accompanied by the rattling of chains.

"Citizen, these wretched beings are made violent by the shackles they are forced to wear," the doctor told him. Then in his thin, reedy voice, he went on to explain that once he had won the respect of the inmates, he entered their cells in perfect confidence; that he planned to proceed cautiously with plenty of guards at hand (here Pussin stepped forward just a little) in case he had made an error of judgment, which he did not anticipate since

he knew each of the lunatics from whom he wanted to remove the chains.

At last Couthon said, "Well, go ahead; you may do what you please with them, but I fear you will become their victim." Pussin had the impression that Warder Couthon would actually regret it if the doctor met with a violent death.

Though Pussin was certain no such thing would happen, he felt a bit apprehensive now that the moment had arrived. The doctor looked particularly small and ineffective walking along beside the burly blacksmith who was going to strike off the shackles. Pinel always seemed to be drawing back a little. This timid manner of his had at first given the attendants the impression that he was a coward. They had scarcely been able to believe their eyes when they saw him enter the cells by himself and stay there for as much as an hour at a time. "I tell you it's unnatural," one of the guards had reported, crossing himself so piously, Pussin thought, that you'd never guess how many years it had been since he'd seen the inside of a church. Not wanting these unenlightened men to suspect M. Pinel of being in league with the devil, Pussin told them of an animal trainer he had known who moved fearlessly about in a cage of roaring lions, yet was afraid of his own wife. And so they had come to regard the superintendent as they would a circus performer with his own particular brand of courage.

"Here, Citizen Blacksmith, this is one of those whom

we are going to release from their chains," Pinel said.

Some of the attendants gasped. The cell before which Pinel had stopped housed the Captain, an English officer who had been incarcerated so long no one even knew his name. He was particularly feared, a huge man who had killed an attendant by striking him with the chain fettering his wrists. Since then the guards had taken the precaution of shortening his chains so that he could not stand up, but could just reach the pan of gruel and bread they pushed into his den each day.

Glancing about him, the blacksmith squared his powerful shoulders and threw out his chest to show he was not afraid; but he let the little doctor precede him when the iron door was unlocked. Had there been room enough inside, Pussin would gladly have joined the ill-assorted couple, but as it was, he had to content himself with standing ready at hand.

Peering into the cell, Pussin was just able to distinguish the form of the Captain huddled against the farthest wall, where the light did not reach. The doctor was talking to him in the calm, firm, reassuring manner he always used with the inmates.

"Don't be afraid, Captain, I'm not going to hurt you; I wouldn't hurt you, because I am your friend. I won't let anybody hurt you, so you have nothing to fear. This man with me is a friend also—I bring him to remove your chains. You remember I promised to strike off your chains so that you could go outside—go outside every day, and have a nice clean cell waiting for you when you

come back, and no chains, so you could stand up any time you liked. . . ."

The doctor continued to talk soothingly while the blacksmith went to work and the sound of chisel on iron rang through the cell. He kept reminding the Captain of his promise to be very good in return for this great favor; without making it sound like a threat, he remarked several times that there would be guards watching him so he must be very good.

When the Captain's wrists had been freed, the doctor helped him into a pair of sleeves he had brought along — a very clever invention, Pussin considered it, for the sleeves were joined to each other at the ends so that the Captain's hands would not be free to choke the life out of anybody. At last the blacksmith was finished, and he made his exit backing out, reluctant to take his eyes off the madman until he was safe in the open.

Now there was room in the cell for Pussin. He helped the Captain to his feet, speaking reassuringly in a hoarse voice, which he tried to make as much like the doctor's as possible. "You know me, *mon vieux* — Pussin, your friend Pussin, come to help you out of this pigsty. Up, up — that's the way. Pretty wobbly, aren't you? But that will pass when you've had a chance to stretch your legs a bit."

It was some time before the Captain's legs would support him. How long it was, Pussin thought, since he had stood on them as the good Lord intended His children to stand!

"Now, Citizen Pussin, we go outside," Pinel said. "The Captain is going to join us of his own free will. No one will force him to do anything as long as he conducts himself properly — as I, his friend Pinel, have every confidence he will."

Out in the clean sunlight, Pussin exhaled vigorously. "Phew!" The guards, standing at attention, looked very formidable. Suppose they frightened the Captain, or he saw one of them who had used him with particular cruelty? Pussin wondered whether it wouldn't be too much for any man, even a sane one, to resist the impulse for revenge. We should have started with someone smaller than the Captain, he told himself; if he hurts anybody now, we'll have trouble with the attendants about all the others. Yet if things went well with the Captain, the rest of the inmates would present no problem. This must be the way the doctor had reasoned; no one could say he didn't use his head.

A gasp of horror signaled the appearance of the Captain at the entrance of his cell. Pussin, seeing him for the first time in broad daylight, found him a shocking sight, the more so as he realized in a flash that it would fall to his lot — as the one person capable of performing the task — to clean the Captain's person. I'd rather clean the cell, he thought, eying the matted hair and the long beard that made the man seem almost faceless as he stood swaying and blinking his eyes. Even although the Captain was unable to stand up straight, he was taller than Pussin had expected.

There he stood like an animal at the entrance of its lair, as though he did not realize he was at liberty to go out. When it did dawn on him, what would he do?

The attendants who had teased and goaded him the most backed away until Pinel flashed a glance in their direction; then they paused, still prepared to cut and run.

"Now you are free, *Monsieur le Capitaine,* so long as you behave well, in accordance with your promise."

Pussin looked at the fragile man who spoke so calmly of promises to the monster confronting him. What must Pinel be feeling? If things went wrong now, after he had worked so hard, day after day, had risked his life over and over again, as much by going to the Warders of Paris as by entering the cells of the inmates . . . Suddenly Pussin realized that he no longer wanted the experiment to succeed because it would make his own work pleasanter, or because of what it would mean to the inmates, but purely and entirely for the sake of M. Pinel.

The Captain took a few uncertain steps forward—at which the guards gave ground, while the blacksmith's hand closed firmly on his hammer. The Captain looked about him; then, as a shadow fell on the courtyard, he glanced up, startled, at the creamy mass of clouds that had drifted across the sun. His face twisted and his lips worked hideously. Even Pussin found himself thinking: now he will run amuck.

Instead, he stared at the fleecy clouds, and the words his lips framed were, "How beautiful." Then he stag-

gered toward the doctor. "Thank you," he said in the voice of a little boy. "Thank you for the sky."

Philippe Pinel smiled.

On that day, in the courtyard of the Bicêtre, Philippe Pinel gave a new and enduring idea to the world when he said, "Strike off the chains, study these people, give them as much freedom as possible and something useful to do; for the insane are not monsters, they are human beings who happen to be ill in a special way."

# 6

## *The Death of Pain*

CRAWFORD W. LONG, 1815–1878; HORACE WELLS, 1815–1848; WILLIAM T. G. MORTON, 1819–1868

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JAMES M. VENABLE hesitated before knocking on Dr. Crawford Long's door. He was wondering whether there was any way he could again back out of being operated upon without ruining his reputation as a brave Southern gentleman. Twice he had discussed the operation with his friend Long, agreeing that the growth on his neck should be removed before it became unsightly, even disfiguring; and twice he had changed his mind. Then this morning Long had brought up the subject again, explaining that he had a new idea. Some time ago a traveling lecturer had demonstrated the effects of nitrous oxide, which had made quite an impression on the audience; to show his friends how much he knew, Long had proved that one could obtain the same results by inhaling ether. Long now reminded Jim Venable that several of the fellows had stumbled or fallen down after inhaling the vapor, bruising themselves without feeling anything until

much later. "I'm sure you won't feel any pain if you breathe in some ether first," he had assured his friend.

Although Venable recalled that the ether could make one feel nauseated, he had agreed to try it. But now that the time had come, he felt different about it. His hand hovered lightly over the back of his neck and he shuddered, thinking of the knife. "It's such a little tumor," he told himself; "why not leave it alone and see if it gets any bigger?" But of course it would hurt less to have it removed while it was still small. He shifted from one foot to the other, arguing with himself. Long had said it would only take a minute, and he could stand that. But still . . .

The door opened. "Come on in. I reckoned it was your footsteps I heard," said Long. "The others are here already."

The surgery was crowded with men in their late teens and early twenties, the young bloods of Jefferson, Georgia, who had grown up on neighboring plantations and gone to school together. James Venable squared his shoulders. "Evening, gentlemen," he said.

Afterward he was glad he hadn't made any fuss, for the truth of the matter was that he felt absolutely nothing after he lay down on the couch with an ether-soaked towel over his face. He couldn't believe the ordeal was over when he sat up, feeling giddy, and heard Long's strangely roaring voice announce that the tumor had been removed and the wound sewed up. Some of the fellows insisted Long had mesmerized him; they had attended

a demonstration of hypnotism about the time they had gone to the nitrous oxide exhibition. Whatever it was, Venable assured his friend, he approved of this method of killing pain during an operation.

The older people of the community disapproved heartily. Some day, they muttered, Crawford Williamson Long would go too far with his ether experiments, and kill somebody, and then they would have him up for manslaughter — possibly lynch him. People had always suffered during operations, as the Almighty intended, and He certainly wasn't going to choose a young country doctor in the year 1842 to change all that.

The opposition distressed Long, who had always enjoyed his popularity. He used ether to remove a second, smaller, tumor from Venable's neck, and for his next half-dozen minor operations — no major ones came his way. Each time the patient said he felt no pain. Yet even with the support of his young wife, Long could not hold out against the community. He gave up his experiments, to the satisfaction of everyone except the people who had to suffer during operations. But as everyone agreed that pain and surgery always had gone and always would go together, there was nothing to be done about that.

In 1844 a Grand Exhibition, such as the one Long's friends had attended, was held in Hartford, Connecticut, to demonstrate the effects of nitrous oxide, which was called "laughing gas" because it made people who inhaled it giggle and act foolish. These exhibitions were a

typically American institution. The theater and ballet were considered sinful, especially in small towns, but anything "educational" was approved of, for in America education was not reserved for a few high-brows as it was in European countries. The wonders of nature in the shape of a two-headed calf, demonstrations of hypnotism in which young men from the audience made fools of themselves, a gas that made a balloon rise into the air — these things could always draw a crowd willing to drop silver coins into a passed hat. Of course, there was a good deal of fakery, for anybody who felt like it could call himself a professor; but as long as people were under the impression that they were learning something and being entertained at the same time, everybody was satisfied.

At the Hartford exhibition, one of the "respectable gentlemen" chosen to inhale the gas became very excited and ran around the lecture hall, not even stopping when he cracked his shin as he stumbled over a bench. Suddenly the effect of the gas wore off, and he sat down sheepishly in the first available seat while the audience applauded.

He happened to sit next to Horace Wells, a handsome young dentist who was attending the affair with his wife. After a few minutes Wells noticed that something was troubling his neighbor. "Is anything the matter?" he asked.

"It's my leg." Cautiously the man pulled up his trouser leg, and Wells, leaning over, saw blood on his shin.

Sympathetically he said, "That's a nasty cut. I thought

you must have bruised yourself when you fell over that bench. You've got a lot of spunk to keep on going the way you did when it must have hurt you badly."

Wells's neighbor shook his head in a puzzled fashion. "I didn't feel anything," he said.

Horace Wells was tremendously impressed. He could scarcely wait till morning to get some gas from the lecturing "professor" and try out his wonderful idea; he was going to use nitrous oxide when he pulled teeth. The very next afternoon he did — or, rather, he had one of his own perfectly good teeth pulled by a dentist friend after the "professor" had given him some gas to inhale. Wells knew how painful extractions were. When he came out of the gas without having experienced the slightest discomfort, he was certain he had the answer to that problem, and to his own financial problems at the same time; for surely everybody would go to a dentist who really could pull teeth painlessly.

Unfortunately Horace Wells did not have the patience of a scientist. He made some, but not enough, experiments before he rushed off to Boston and persuaded the Harvard medical faculty to let him demonstrate his method. With the help of a former partner, William Thomas Green Morton, Wells pulled the tooth of a medical student volunteer. He gave too little gas, and the student howled in pain. The demonstration was a failure.

Back in Hartford, Wells attempted another demonstration. Anxious to avoid his previous mistake, he gave the

patient so much gas that it nearly killed him. There was such a storm of protest that, for the time being at least, Horace Wells put aside his dream of pulling teeth painlessly.

Twice within two years a way to prevent suffering had been offered to the world, and had been rejected. The world was like a nursemaid throwing away something a child has thrust into her hands, without bothering to notice that it is a precious jewel.

The priceless boon of relief from the pain of surgical operations had been picked up and discarded many times, even before Paracelsus made "sweet vitriol" (ether) in the sixteenth century and discovered it would put chickens into a harmless sleep. Once the world had almost paid attention — in 1828 when kindhearted Dr. Henry Hill Hickman petitioned France's Royal Academy of Medicine to let him show that operations could be performed painlessly with the aid of nitrous oxide. Baron Larrey, Napoleon's surgeon, who appreciated the suffering of the wounded soldiers, wanted to give Hickman a chance; but the others voted him down. How long would people have to endure the agony of operations while the world continued to throw away the jewel that was pressed into its hands?

Not long — the intervals were not a hundred years apart any more, or even twenty years. Equally important, the scene of the discoveries had shifted from Europe to the United States, and the doctors of the new world were

not so inclined to dismiss a thing simply because it was new.

In 1846 Wells's former partner, William T. G. Morton, went to Dr. John Collins Warren of the Massachusetts General Hospital and told him that he had a safe method of rendering operations painless. Dr. Warren listened, even though quacks and fakers were constantly claiming all kinds of marvelous things. Dr. Warren was inclined to be forbidding, which was considered proper for a man of his age and importance. He was also very cautious about risking the reputation of the hospital which he himself had established in 1811. He almost sent Morton away when the young man wouldn't tell him what his preparation was. But he didn't. He had seen too many operations, had performed too many operations, for that.

Besides, his years of experience had taught him to recognize conviction whenever and wherever he saw it, to tell the difference between a faker and a man who simply wanted to make money out of his discovery. Being a Warren of Boston had taught him not to be afraid to back his own opinions. "I'll try your plan," he said.

Morton had every right to be convinced that his method was a good one, for he had been working on it carefully and conscientiously for two years.

His wife's family had not approved of her marrying a poor dentist, so he was studying medicine to improve his social position, and working hard at dentistry to support his family. The only way a young dentist could hope to get ahead was by doing something different from, or

better than, his competitors. Morton worked out an improved method of crowning teeth — only to discover, as other dentists had, that patients weren't interested in improvements if they hurt. The old ways of easing pain — a good stiff drink or a dose of laudanum (which is a dangerous opiate) — weren't good enough. He determined to find something better.

During the early days of his marriage, before he could afford a home of his own, Morton and his wife had boarded with one of his teachers, Charles T. Jackson, a well-known physician and chemist. Jackson happened to mention the fact that ether numbed the skin. This gave Morton the idea of putting it on a patient's aching tooth. It did some good, but not for very long.

After Horace Wells's demonstration, Morton began to wonder whether ether fumes might be better than nitrous oxide. Unlike his former partner, and unlike Long of whom he had not heard, Morton decided to find out everything he could about ether. Apparently it wasn't dangerous, for doctors had their patients inhale ether in order to gain relief from asthma. Morton's studies were finally rewarded when he came upon a paper written by the chemist Faraday in 1818 — the year before he, Morton, had been born — describing the pain-killing properties of ether and comparing them with those of nitrous oxide.

In addition to reading, Morton experimented constantly. He used his wife's dog, and her goldfish and — when she complained about that — mice and insects and himself.

He thought he had found out all there was to know about ether when he ran into trouble: sometimes the ether he gave produced excitement rather than insensibility. As long as such a thing could happen even occasionally, Morton faced the same danger that had ruined his ex-partner, Wells, who had given up dentistry altogether and was trying to make a living by selling a new contraption called a bathtub.

Morton wanted to talk his problem over with a good chemist. The obvious choice was Jackson, with whom he had managed to stay on fairly good terms, although there had been friction between them while Morton had boarded there. But Morton was afraid Jackson would want a share in his project. He had good reason to be concerned, for Jackson had insisted — and some people believed him — that he was entitled to the credit of having invented the "magnetic telegraph." He said he had given Morse the idea for it when they were crossing the ocean on the same ship in 1832.

Morton finally decided to sound Jackson out very carefully, without letting his former teacher-landlord suspect what he was really up to. He was so cautious about it that Jackson not only did not suspect he had been experimenting with ether for over a year, but afterward was certain he himself had given Morton the idea in the course of their conversation.

Morton never stopped to think of the trouble he was letting himself in for; he was much too excited with the success of his little scheme. For, in the course of their

talk, Jackson had remarked that the ether sold in a certain pharmacy was pure sulphuric ether, much better than the impure stuff sold by other apothecaries. Thinking back, Morton realized that the experiments he had made with ether purchased at that store had always been successful. Careful to use only rectified sulphuric ether from then on, Morton got uniform results from his experiments.

After more than eighteen months of work, William T. G. Morton was ready: he had removed a tooth without causing the slightest pain; and he had worked out, with the help of an instrument maker, a device for giving ether that was far more satisfactory than a saturated towel put over the patient's face. He refused to be discouraged when the first surgeons he approached turned him down; at last Dr. Warren agreed to let him administer his painkiller to a patient on whom he was going to operate.

The medical students who filled the wooden U of benches in the amphitheater of the Massachusetts General Hospital on Friday, October 16, 1846, had no idea what they were going to witness. They knew something was up because the operation — on a congenital tumor of the neck — was not important enough to draw the distinguished doctors who crowded the floor of the room: Dr. Bigelow and his son, Dr. Gould, Dr. Parkman, Dr. Townsend and Dr. Haywood. The young men whispered about it, hushing quickly when Dr. Warren cleared his throat before saying, in his precise manner:

"Since many of you have not been informed for what purpose you have assembled here, I shall now explain it to you. There is a gentleman who claims he has discovered that the inhalation of a certain agent will produce insensibility to pain during surgical operations. . . . After due consideration I have decided to permit him to try the experiment."

The students were tremendously excited, their low voices making a sound like footsteps scuffing on a sanded floor.

Time passed and nothing happened. The spectators began to stir restlessly, and so did the burly attendants who stood by the operating chair, ready to hold down the patient in case this new method of deadening pain turned out to be no more effective than the others that had been tried. The patient, a thin young house painter named Gilbert Abbot, was looking worried. Dr. Warren consulted his watch — almost ten-thirty and the operation had been scheduled for ten. He clicked shut his watch case, drew down his long upper lip, and said sarcastically, "As Dr. Morton has not arrived, I presume he is otherwise engaged."

This, the students knew, called for an appreciative laugh, which they ended as Dr. Warren went over to his patient, felt out the tumor, and nodded to his son, Dr. Jonathan Mason Warren, to hand him the knife.

In the breathless silence that always preceded the initial incision, the door opened suddenly and Dr. Morton burst into the room. The students couldn't hear what he said,

and his flowing mustache made it hard for them to read his lips; but he was apparently apologizing for his lateness, and indicating that it had something to do with the apparatus in his hand.

Dr. Warren's only comment was, "Sir, your patient is ready."

Morton spoke to Gilbert Abbot, who was reclining on the operating chair. "Are you afraid?" he asked. "There is a man here who has breathed this and can testify to its success."

"No, I feel confident, and shall do precisely as you tell me."

Morton leaned over and applied to Abbot's lips the

mouthpiece of a tube which was connected with the glass object he was holding, meanwhile speaking to the patient in a low voice. A curious, sweetish odor drifted to the nearby spectators; some of them thought they detected the smell of ether in Dr. Morton's secret concoction.

Five minutes passed. The room was quiet save for one moment when the patient struggled briefly, at which some students gasped.

Removing the inhalator from Abbot's mouth, Morton turned to his superior and said, "Dr. Warren, *your* patient is ready."

The young man in the operating chair was motionless. The spectators, too, seemed to be under a spell. As Dr. Warren deftly passed a curved needle threaded with a ligature under and around the tumor, they leaned forward in unison. Was this the moment for which the world had been waiting? Everyone was suddenly very much aware of the two powerfully built attendants who stood by, ready to hold the patient if he should begin to struggle.

The young man did not stir; there was not even an involuntary contraction of his body as the operation proceeded. Then his head turned; he was muttering something. A gasping sigh of disappointment rose from the audience; this, too, was going to be a failure.

But Gilbert Abbot relaxed again, as though he had returned to a deep sleep after being disturbed by a nightmare.

Dr. Warren moved back, straightening his tall old body, watching the patient closely. The operation was over. Ex-

cited whispers seemed to dance through the amphitheater. As the patient's eyelids began to flutter, Dr. Warren bent over again. "Did you feel any pain?" he asked, and again the room was absolutely quiet as everyone waited for the answer.

Abbot's voice was blurred. It drifted away and then came back again as he spoke slowly, with an effort. "No — pain. No pain. Someone . . . I felt as if someone — was scraping my neck — with a blunt instrument." His eyes closed drowsily.

Dr. Warren turned to the audience. "Gentlemen," he said. "This is no humbug."

Although the demonstration was greeted with great enthusiasm, physicians wondered whether Morton's device would work in major operations. Dr. Warren said he would test it on an amputation he was scheduled to perform.

At this point the Massachusetts Medical Society raised objections because Morton had applied for a patent on his invention. Morton quickly agreed, in writing, to give the Massachusetts General Hospital (to which he added the country's other hospitals) "the free use of it for all the hospital operations."

That satisfied Dr. Warren and some of the others, but it did not satisfy the society. On November 7, as Dr. Warren's patient — a young girl named Alice Mohan — was about to be taken into the operating theater to have her leg removed, the society announced that its members were

forbidden by the rules to use "secret remedies." This was a good rule, for doctors ought to know what they were giving their patients. However, Dr. Warren and some other important physicians, including Dr. Henry J. Bigelow, felt that an exception could be made in this case. A great argument followed — while Alice Mohan waited in an anteroom. Finally, Dr. Bigelow appealed to Morton.

Morton did not see why he should risk his chances for a fortune by telling what his Letheon was before the patent on it had been granted. The patent would come through in a few days, and then he would be sure of making the money he needed so badly. He had his family to consider — and weren't they more important to him than whether or not one girl would have to endure pain which his ether could prevent? For centuries people had been suffering during operations; why shouldn't he let one more patient suffer? Or why shouldn't the medical society give in as long as Dr. Warren was willing?

Everything in William T. G. Morton told him to refuse to answer the society's question. Yet somehow he knew there was a bigger question he could not refuse to answer: it was, "Do you want to be worthy to be a doctor?"

Morton rose to the occasion. "It is sulphuric ether," he said; and the operation could proceed.

Poor Alice Mohan, who had been forced to wait, not knowing what was going on, was exhausted by the strain. Obediently she followed Morton's directions when he put the mouthpiece of the inhaler to her lips. The next thing

she knew, Dr. Warren was tugging at her sleeve and saying, "I guess you've been asleep, Alice."

"I think I have, sir," she agreed.

"Well, we brought you here for an amputation; are you ready?"

"Yes, sir, I'm ready."

And then he told her, "It is all done"; and the audience went wild.

Yes, this was it. At last something had been found to eliminate the agony of surgical operations, something far safer and more effective than the old methods — whisky, mesmerism, freezing the site of the operation, bleeding the patient until he fainted; and it was

> Not poppy, nor mandragora,
> Nor all the drowsy syrups of the world

which doctors used to give their patients, and which often brought "sweet sleep" from which they would never awaken.

"I have seen something today that will go round the world," said Dr. Bigelow. Others called it "the greatest mercy shown by man to man" and "the most God-like discovery of this or any other age." "Everybody wants to have a hand in a great discovery," wrote Dr. Oliver Wendell Holmes to William Morton; and he proceeded to play his part by suggesting a name. "The state should, I think, be called 'Anaesthesia' . . . the adjective will be 'Anaesthetic.' "

Bigelow was right in saying it would go around the world. Within two months Robert Liston was performing a major operation with the aid of ether in London, informing his students when it was over that "This Yankee dodge, gentlemen, beats mesmerism all hollow."

Of course there was a great deal of opposition. Some of it came from the people who were certain they knew exactly what God wanted, and that it included enduring pain during operations. The Scottish surgeon James Y. Simpson, who preferred chloroform to ether, met with terrific opposition when he began giving a few whiffs of it to women who were having babies; but, knowing the Bible practically by heart, he was able to outquote his opponents.

A great many surgeons opposed anesthesia for personal reasons of which they were not always conscious. Ether would mean that speed was no longer *the* essential, and they had worked unbelievably hard to acquire speed and dexterity. Some of them operated so rapidly that students used to be afraid to wink for fear of missing something; and one of the stories that went around concerned a surgeon who, with one sweep of his knife, had cut off the limb of his patient, three fingers of his assistant, and the coattail of a spectator! Actually, surgeons worked very rapidly: for example, Robert Liston's cousin James Syme used to perform the complicated amputation at the hip joint in exactly one minute.

Despite the opposition, anesthesia caught on everywhere, and Morton should have been the most honored

and the happiest man in the world. Undoubtedly he would have been if it had not been for Dr. Charles T. Jackson. As soon as he was certain ether was a success, he claimed it as his own idea: Morton, he said, was only a pupil of his who had worked out some practical details at his suggestion. People paid attention to Jackson because he was a far more important man than the unknown dentist; and he certainly maneuvered cleverly.

Then Wells began to think he ought to have the credit. He got less support than Jackson, and after a while turned to experimenting with chloroform, hoping James Y. Simpson was right and it would turn out to be better than Morton's ether. Wells was an unstable person. Enjoying the dreams he had when he sniffed chloroform during his experiments, he became addicted to it, sank lower and lower until, quite out of his mind, he threw acid in a girl's face. Upon being arrested and put in jail, he committed suicide.

Crawford Williamson Long was a different kind of man, easygoing and honest. He had always intended to "do something" about his ether operations; and when the world became excited over the Boston demonstration, he couldn't resist calling attention to the entry in his ledger for 1842: $2.00 for removing a tumor from the neck of James M. Venable after having him inhale ether. Long still hated unpleasant situations, but with everybody egging him on, from Jackson, who would stop at nothing to discredit Morton, to the super-Southerners who had to prove Georgia was four years ahead of Massachusetts, he

could not keep from becoming involved. Eventually he reached the point where he wished he had never heard of ether, for it caused him only trouble.

Morton, who had put aside his dreams of being a rich man in order to help humanity, found himself in every kind of trouble Jackson could stir up for him, trouble which occupied his time so completely that he was even forced into bankruptcy. Jackson spread the rumor that Morton had cheated his former partner, Horace Wells, driving him to insanity and suicide. Although the doctors at the Massachusetts General Hospital stood by Morton and insisted that he get the credit, Jackson always managed to prevent it. The nation — even the world — wanted to express its gratitude, but with Jackson and some of his influential friends constantly at work, there was always the possibility that Morton was not really the man who should be honored.

Over and over again Morton's hopes would be raised and then dashed again. There must have been times when he thought of the story of Prometheus, who brought fire to mankind and whom the gods punished. Every day an eagle tore out his liver, and each night it grew again. As far as William Morton was concerned, no eagle could compare with Charles T. Jackson.

Finally, Morton could stand it no longer, and his health gave way. In July, 1868, he read a particularly vicious article Jackson had written about him, and collapsed from a heart attack. As soon as he could travel, he hurried to

New York to answer Jackson; there he collapsed again while he was driving with his devoted wife, and died without regaining consciousness.

Ten years later, Crawford Long—who had been impoverished, like so many other Southerners, by the Civil War—attended a poor woman who was having a baby. When her husband begged him to give her something to ease her pain, he got out the ether that had made his own life miserable. As he was about to administer it, Crawford Long dropped dead.

Wells and Morton and Long were all gone, but Jackson continued to fight. His hated rival's death did him no good—in fact, people were honoring Morton now as they never had done while he was alive. Jackson reached the point where he did nothing but drink and write articles to prove that he, and not Morton, should be called the "benefactor of mankind." His obsession grew until one summer day in 1873 he went to the cemetery and stood glaring up at the monument erected to Morton by the citizens of Boston. It said INVENTOR AND REVEALER OF ANESTHETIC INHALATION, BY WHOM PAIN IN SURGERY WAS AVERTED AND ANNULLED. Over and over Jackson read the lines; and then he began to scream in a frenzy of rage. The police had to carry him away; and he ended his days in an insane asylum.

None of the men who had contributed, in one way or another, to the discovery of anesthesia, derived the slightest benefit from it. The "ether controversy" became the

"ether tragedies"; and then it faded from people's memory, eclipsed by the magnitude of the discovery itself. Gradually people found that, in addition to relief from pain, anesthesia was to make possible tremendous advances in surgery.

# 7

# *Another Herakles*

## JOSEPH LISTER, 1827–1912

JOSEPH LISTER, professor of surgery at the University of Glasgow, was not satisfied with conditions on the surgical wards. Eight out of every ten amputation patients died —a much higher mortality than he had been accustomed to in Edinburgh where, until recently, he had assisted his father-in-law, the famous Scottish surgeon James Syme. Lister wondered why this should be so, for the surgical wards of Glasgow's Royal Infirmary were in a new, well-designed building, and he was able (with considerable difficulty) to keep the authorities from overcrowding them too badly.

In 1863 it was unusual for a surgeon to be personally concerned about a high death rate as long as the patients did not die while he was operating upon them. It was not his fault if they came down with one of the various forms of septic (or putrid) diseases called "hospitalism." In those days patients almost never recovered uneventfully from operations. No one expected a wound to heal cleanly. Be-

lieving there were impurities in the wounds themselves, and that these had to come out, doctors spoke approvingly of "laudable pus" or "kindly suppuration." The patient was lucky if he got off with nothing worse than an inflamed wound that healed slowly, leaving a thick scar.

More often than not the "kindly suppuration" would be followed by erysipelas, pyemia, septicemia or gangrene — diseases which, when they struck a hospital in full force, could kill every patient on a ward. When that happened, the doctor could only remember John Bell's advice: "Let the surgeon bear in mind that this is a hospital disease, that without the circle of the infected walls, men are safe; let him, therefore, hurry them out of this house of death." Unfortunately it was not possible to follow this advice as there was no place to take the poor patients.

No one knew why hospitals should be houses of death. Most doctors agreed that it had something to do with polluting vapors, which they called "miasmas," that hovered about hospitals, entering wounds and causing them to decay. When these miasmas became unusually bad, an epidemic would result. The reason why they got bad? Oh, cosmic telluric influences caused that. (This meant — if it meant anything — vast earthly influences.) Nobody could do anything about them.

John Eric Erichsen, whom Lister had once served as a dresser, had a slightly different theory: he said that miasmas came from the wounds themselves, polluting the atmosphere and getting into other wounds; he even figured out the number of cubic feet per patient one had to allow

to prevent the miasmas from getting too dense. Lister didn't subscribe to this theory, although he did believe that overcrowding was bad; he would have liked each of his patients to have a bed to himself. This was considered impractical.

Hospital diseases had been increasing in severity as cities became more and more crowded, but there was nothing doctors could do about that. The coming of machinery had forced the handicraft workers out of business, driving them from their clean moors to the cities where the factories were located. As doctors couldn't possibly take care of them in the filthy hovels where they lived, they had to go to the crowded hospitals when they became ill or were injured.

Lister cared deeply about the poor patients. His people were Quakers — who by tradition are very charitable, anxious to relieve suffering and unwilling to cause it even by hunting animals. Personally very sensitive, Lister would never have chosen surgery if anesthesia had not been discovered while he was at medical college. With chloroform (which was more popular than ether in Britain) a surgeon could operate slowly and carefully without causing pain. Yet he could not spare the patient the suffering and possible death that followed operations, suffering and risk that restricted surgery to procedures that were absolutely essential. Lister was not the type of surgeon who could cry triumphantly, "The operation was a great success! The patient? Oh, the patient eventually died." Even as a student Lister had wanted to know why the patient

died, and whether or not anything could have been done to prevent it.

It was natural for him to turn to a microscope in this work, although many doctors disapproved of it, believing its use would prevent them from developing their powers of clinical observation. He had been using the microscope since he was a boy. His father, who was a scientist as well as a successful merchant, had made a number of important contributions to microscopy, and was credited with raising the instrument "from little better than a scientific toy to a powerful engine of investigation." Joseph was the fourth and middle child in this family of three girls and four boys, all of whom enjoyed examining botanical specimens through their father's microscope. Extremely good-looking, shy, and with a little stammer he was never entirely to overcome, Joseph loved anything connected with science. He had always wanted to be a doctor.

When, as a student, he examined the material from decaying wounds under his microscope, he noticed — as he put it — tiny "bodies of a pretty uniform size, which I imagined might be the *materia morbi* in the shape of some kind of fungus." While he did not suspect that he had seen anything important, he remembered his observation.

Later he studied and tried to understand the nature of inflammation — the first stage of wound infection — writing an excellent paper on this subject; it prepared the way for many of his later discoveries. In it he said that irritation causes a loss of vitality in the tissues, and that

during this temporary death, or paralysis, they are as helpless to defend themselves as dead cells would be. Everyone, of course, knew that dead cells were bound to decay.

This did not answer the problem Lister faced in 1863: how to reduce the mortality in his wards in the infirmary. Yet it was in the back of his mind when he wondered whether dirt could be the cause of wound infection, for he had noticed through his microscope that bits of dirt caused irritation when he injected them into the tissues of frogs. He was fairly certain that the air alone was not to blame, for in none of his experiments had he noticed any irritation resulting from exposure to air. Besides, the medical wards were seldom contaminated by hospital diseases even when medical cases who happened to have minor wounds were included among the patients; similar wounds often "went bad" on the surgical wards, which were far dirtier than the medical ones. Could the dirt, by irritating the wounds, be to blame? He could see no harm in trying to keep dirt out of wounds.

This was a revolutionary suggestion to the trustees of the infirmary. Everyone associated surgery and dirt. A surgeon who might dress exquisitely in society would keep a special coat for operations and ward work, never bothering to have it cleaned (a dirty operating coat proved that the surgeon was popular enough to operate frequently); when it became stiff with encrusted blood and filth, he threw it away and started in on another coat. As for washing one's hands before an operation — why, that was what one did afterward. This was traditional. Sir Ast-

ley Cooper, one of the finest gentlemen of his day, operated on King George IV with a knife which he borrowed from the pocket of a friend, not even bothering to wipe it on his greasy coattails before he cut into the royal flesh. Doctors who objected to "that good surgical stink" were considered finicky.

Nevertheless Lister battled with the economical hospital authorities until they bought some soap and scrubbing brushes, with which he managed to have his wards cleaned up a little. It did no good. The septic diseases continued; scarcely a compound fracture (a fracture in which the broken bone is exposed through an open wound) came into his wards that did not "go bad" and end in an amputation. Lister was being forced to the conclusion that, in cases of compound fracture, one should cut off the limb immediately; since it would have to be done sooner or later, the operation should be performed while the patient was still in comparatively good shape.

What Lister could not understand was why simple fractures, in which the skin was not broken, healed without difficulty. It was something he discussed frequently with his wife, especially late at night when she would take dictation from him in his laboratory.

"Two little boys were brought into the ward today, Agnes," he told her. "Both with broken bones — run over by a cart. The older boy was badly injured, the younger scarcely bruised. Yet Jock is going to be all right because, badly though he's hurt, the fracture is a simple one; while poor Andy will probably lose his leg. Only four years old

and such a brave little street sparrow he is! I keep wondering whether I did right to let him stay in the hospital when he might be safer in his own home, and yet I couldn't leave him there with no one to care for him, both of his parents working all day to earn a miserable living."

"If only you could bring him here to me," said Agnes Lister, who loved children as much as her husband did. Although their marriage could not have been happier, they both regretted having no children of their own.

"The authorities would never permit it; they think me far too critical of the infirmary as it is. And I have no way of knowing that he really would be better off. If only I had some idea as to what it is that causes hospital diseases. I feel certain it has something to do with the skin being broken—else why would bruised tissue heal without difficulty when the skin is intact? But until I know what it is, anything I do is like bolting the door against a killer who only laughs because he always comes in through the chimney. If only I could find some clue as to what it is that enters an open wound."

By this time a book on the cause and prevention of childbed fever had been written by Ignaz Philipp Semmelweis, a Hungarian obstetrician. It might have provided Lister with the clue he was seeking, for Semmelweis said that puerperal fever was caused by particles of decayed material carried on the physicians' hands, particles so tiny that casual rinsing wouldn't get rid of them. (While childbed fever was not the same thing as a

postoperative disease, certain similarities had been noticed; John Bell had pointed out, some years before Lister was born, that "ulcer and gangrene is in a hospital what puerperal fever is in a lying-in ward.")

But Semmelweis's book was not published, so Lister did not hear of it; and it was not until early in 1865, the year of the tragic Hungarian's death in an insane asylum, that Lister found what he was looking for. It was in the paper *Recherches sur la Putréfaction,* written over a year before by the French chemist Louis Pasteur. It was more than a clue, it was a complete answer for every surgeon who asked about the cause of wound infection; yet none of them noticed it except Joseph Lister.

"Living ferments" cause putrefaction, said Pasteur; and what, Lister asked himself, were suppuration and gangrene but the decay of tissues which, although not actually dead, had lost their vitality as the result of injury and irritation? Everyone knew that the blood in a wound decomposed—within twenty-four hours after an accident or operation one could easily distinguish the odor of decay. Now Lister knew why. It was not oxygen or a miasma or even dust and dirt, but "germs of various low forms of life" that got into a wound and caused it to putrefy. He had seen these germs himself, without knowing what they were, when he had examined material from gangrenous wounds through his microscope. No wonder germs were plentiful in surgical wards, where they had so much to feed upon.

Now he faced the question: what could he do about it?

He could see no practical way of keeping microbes out of wounds. The tiny creatures would have to be killed. Pasteur said heat would kill them, and this was why using a cautery to burn infected wounds sometimes did some good. But heat was painful to the patient, and it retarded healing by destroying additional tissue. Pasteur also mentioned chemicals which Lister knew had been used to embalm dead bodies — that is, to keep them from decaying. In a nearby city carbolic acid had been put on the garbage dump to keep it from smelling. Lister resolved to try carbolic acid.

In March he used some on a man who had come into the ward in such poor condition that he felt justified in trying anything. The patient died.

Before he tried it again, Lister experimented for another five months with carbolic acid, thick, tarry stuff called "German creosote." This time the patient was a twelve-year-old boy who had been run over by a cart which broke both bones of his lower leg. The wound was not serious, but Lister, thinking of little Andy and all the other children who had died or lost a limb from similar injuries, decided to see whether he could kill the "living ferments," the germs, that would otherwise undoubtedly cause the wound to decay. He had the torn skin covered with a piece of lint soaked in carbolic acid, and then, after splinting the leg, waited to see what would happen.

For three days everything went well, which was not unusual in such cases. It was on the fourth day that suppuration usually began.

"How are you this morning, Jaimie?" Lister asked in his low, gentle voice. He had been relieved to learn from the nurse that the boy had eaten all his porridge, and now his practiced eye assured him that Jaimie was not feverish.

"Me leg hurts, sir," James answered. "It's supposed to hurt, isn't it, when it's getting better?"

Lister's heart sank. Has this test, also, failed? Has this wound started to suppurate, like the ones upon which microbes had been allowed to thrive? He would know in a minute. Carefully he removed the outer bandage from the injured leg. There was no offensive smell. Next came the lint dressing which, with the serum ooze, had formed a crust over the surface of the wound. A clean surface, already beginning to granulate and heal. Then what had caused the pain? The skin about the edges of the wound was pink, and for an instant Lister's heart stood still. Then he realized that this was not the angry blush characteristic of the first stages of hospital gangrene. This was a superficial irritation, as though something had burned the skin about the edges of the wound. Yes, that was it. Creosote was strong, and having been in direct contact with the boy's delicate skin for over thirty-six hours, it had caused a surface burn.

"What is it?" Jaimie asked anxiously. "Is it very bad? Are you going to cut it off? Oh, please, sir, don't cut off me leg."

"Nothing like that, Jaimie. It's only . . . let me see how I can explain it to you. The medicine I put on your sore was a bit too strong, and it made the skin about the

edges hurt a little. I'll make it weaker the next time."

He looked up, startled, for Jaimie had commenced to cry, great tearless sobs like those of a grown man. "Oh, no, sir, please don't make it weak. I don't care if it hurts, just so it cures me leg. I've me mither and the little yins to take care of, and who's to give me work if I lose me leg?"

Joseph Lister laid his hand on Jaimie's tousled head, and the boy relaxed as he looked up at the man who smiled on him so affectionately. "Don't worry about that, lad," Lister said. "It doesn't have to be strong enough to hurt the skin in order to help your wound. Your leg, with God's help, is going to be all right."

Few doctors had seen a wound heal in a hospital the way Jaimie's did, without a trace of "healthy inflammation" or "laudable pus." Yet Lister was the first to admit that Jaimie's wound was too small to prove anything. He continued using his new technique, improving on it as he went along, on other compound fractures, until he was successful with cases so serious that their recovery created a great deal of excitement around the hospital.

After six months he was doing so well with compound fractures that he tackled one of the most difficult types of cases confronting surgeons — a form of abscess caused by tuberculosis, which almost invariably killed its victims, whether one operated or permitted the abscesses to burst by themselves. As the victims of these psoas abscesses were almost always children, Lister was very anxious to find a way to help them. Besides, if he could prevent blood poi-

soning by opening these deadly abscesses under the protection of carbolic acid, it ought to prove that his method was right.

After experimenting by lancing some carbuncles, he waited until the psoas abscess of one of his patients was about to burst—which, as everybody knew, would result in the patient's death. In the most painstaking manner he battled the unseen microbes as he opened and drained the abscess. The patient's recovery was miraculous; no one had ever known such a thing to happen before.

In March, 1867, Joseph Lister began publishing a series of papers explaining his theory and method, and describing his cases.

It took years for Lister's colleagues to accept what he told them. Even after he managed to obtain co-operation from those who worked with him, so that his own wards were rid of hospital diseases, few surgeons could believe that this modest man with the shy, sweet smile and the unassuming manner had solved the problem of wound infection.

There were a number of reasons why they held back. One of the main ones was that Lister's method was based on an idea which they had to understand in order to make it work. He called it "*anti*septic" (*against* what causes putrefaction) surgery; but they simply called it "the carbolic method." They thought they were following Lister's instructions when they daubed some carbolic acid on a wound and then examined it later with dirty hands, or probed at it with an instrument they had carelessly let

fall on the floor. When the wound became infected, they decided that "Lister's salve" was no better than the other things they had hopefully smeared on wounds. Lister's results were so good, they said, because he was an exceptionally gifted surgeon—calling him modest when he insisted this was not so. (As far as operative technique went, Lister was not exceptionally skillful.)

Some doctors opposed his discovery, a few of them violently. Those who took the trouble to understand the principle behind antiseptic surgery often rejected it because they did not believe in Pasteur's "mythical fungi."

Lister's most violent opponent was James Y. Simpson, who had recently been knighted. Sir James had contributed chloroform to childbirth and fought a good fight to see that it was accepted. But he had his own ideas for solving the problem of hospital diseases. One was the "pavilion system"—in which hospitals were temporary structures, like barracks, and could be torn down and burned when they became too contaminated. This plan had some merit before Lister's discovery, after which it became a little like burning a barn in order to roast a pig. Simpson's other idea was acupressure, the use of needles instead of ligatures to compress severed blood vessels and keep them from bleeding. This, too, was not a bad idea, as the ligatures used to spread infection, and frequently rotted themselves so that they failed to prevent hemorrhages. But Lister solved that difficulty by soaking ligatures in carbolic acid to kill the germs on them. Yet even if Simpson's ideas had not been eclipsed by Lister's discovery, he

would probably have disapproved of antiseptic surgery anyway, for Joseph Lister was the son-in-law of James Syme, for years Simpson's most bitter personal enemy.

In addition to the fact that most surgeons did not want to bother about a theory, priding themselves on being practical men, they objected to antiseptic surgery because it required so much hard work and attention to detail. Some of the hard work was unnecessary, because of the fact that Lister naturally knew nothing about the habits of germs. For example: suspecting the air was filled with them, he said the surgeon should operate in a cloud of carbolic acid, pumped into the air about him by a bellows. Later he invented an engine to spare the assistant, who sometimes used to faint away from exhaustion during an operation; but the "spray" was a fiendish contraption, often drenching the surgeon in a rain of carbolic acid, and always irritating his eyes and lungs. Another thing surgeons objected to was the fact that Lister was never willing to let well enough alone, always changing and improving his technique.

None of these things endeared him to English doctors, who were inclined to look down their noses at anything that came from Scotland — forgetting that Lister himself had been born and raised just outside London. Many German and French — even American — surgeons accepted antiseptic surgery, while English ones remained aloof.

As long as they hesitated, hospitals throughout the United Kingdom would remain unchanged. Lister had, as he put it, the young on his side; but he could not let

people continue to suffer until these young disciples of his were promoted to positions of importance. In 1877 he decided to storm the citadel of London. He accepted a professorship at King's College—in a sense, only half a professorship, as John Wood, who had been in line for the position for years, would share the chair of surgery.

Lister considered this, in a way, to be an advantage since he and Mr. Wood (British surgeons were called "Mister" instead of "Doctor," a holdover from the barber-surgeon days) would each have his own ward. Lister would use antiseptic methods in his while Wood would continue in the old way. By comparing the results on the two wards, people could see for themselves the superiority of antiseptic surgery.

Lister's early days at King's College were discouraging. The students didn't like his first lecture which, instead of being the customary entertaining speech, was a demonstration, complete with charts and test tubes, of the manner in which germs cause milk to sour. This, the students felt, had nothing to do with surgery; it was something so new it didn't even have a name, although some people called it "microscopic horticulture"; the young men could see no sense in studying material not included in their examinations. And so they stayed away from the lectures.

He met with at least passive resistance from the nurses, who could see no reason to follow his complicated instructions, and were pained to discover that even though Mr. Lister didn't yell at them the way the other doctors did, it wasn't easy to put things over on him. Save for

some foreign doctors and the assistants he had brought with him from Scotland, few members of the medical profession paid much attention to Joseph Lister, dismissing him as an inoffensive fellow who did good work even though he did have a bee in his bonnet.

However, when Lister went so far as to operate on a man with a smashed kneecap, they became indignant. This was not a necessary operation, performed in order to save a life or eliminate unbearable pain or remedy a condition that might later endanger the patient. Lister had operated for no better reason than to make a useful leg out of a crippled one; and that was tempting Providence. "When this patient dies, someone should proceed against *that man* for malpraxis," advised one of London's most distinguished surgeons. But the patient did not die. Two months after the operation he was able to go home with a knee that would be practically as good as new.

London was not convinced; other surgeons occasionally performed an astonishingly successful operation. (Later it was easy to see that these surgical miracles were performed in comparatively germ-free private homes and on portions of the body that did not easily become infected.) Nevertheless, London was impressed.

Then Lister was asked whether he would care to operate on a patient with an enormous tumor of the thigh, a case which Mr. Wood had refused, knowing the man was in no condition to survive the postoperative fever he considered inevitable. Everyone would be watching Lister now, and it was not a case he would have chosen for a

test. Yet as the man was certain to die unless his leg was amputated, Lister agreed.

The amputation itself went very well; the test would come later. On the fifth day Mr. Wood appeared on the ward as Lister was about to dress the wound, and Lister, knowing he had come to check up, politely asked him to watch the procedure.

As Lister moved through the ward, Mr. Wood followed awkwardly, being lame. He paused impatiently as Lister stopped by the bed of a patient who, looking perfectly well, was sitting up reading a newspaper. Then, in great surprise, he asked, "Is *this* the man whose leg we all refused to amputate?"

No one was ever less inclined to gloat than Joseph Lister. "Yes, this is he. We shall now change the dressings and see the condition of the wound."

As Lister stooped over the bed to remove the outer bandage, one of his devoted dressers started the spray, having previously lighted the alcohol lamp which provided heat to create the necessary pressure. Fortunately the machine did not go wild; a fine cloud of mist arose, giving the scene an eerie quality. First Lister removed the outer bandage, layers of gauze with a piece of mackintosh inside the last layer, the whole of which had been covered with a sheet of waxed taffeta as a protective. The bandage was handed to Mr. Wood to examine.

Now the wound was revealed — a clean, healing wound, with no shiny grayish slough to indicate the presence of gangrene, no foul-smelling pus, no inflammation.

Surely, Lister thought, if Mr. Wood is an honest man he will recognize the difference between this wound and those of the patients in his own ward.

There were a few minutes of silence, broken at last by Wood's rather rough voice with its harsh Yorkshire accent. "Tomorrow when I operate I should like you to instruct me in your method," he said, and without pausing he headed for the door, where he stopped long enough to add, "Mr. Lister, I thank you."

With a note of deep respect in his voice, Joseph Lister said, "Mr. Wood, I thank *you.*"

The test was over. Wood's conversion gave the necessary impetus to the trend that had already begun, and London was won over to antiseptic surgery.

Now surgical wards changed so rapidly that patients returning for a second operation could not believe their eyes. The filth of centuries was gone, and clean, fresh air replaced the "good old surgical stink."

To the poet Henley, one of Lister's grateful patients, the task was as great as the one Hercules had faced when he was ordered to clean out the Augean stables. He wrote a poem in tribute to "The Chief," ending it with the words:

> We hold him for another Herakles,
> Battling with custom, prejudice, disease
> As once the son of Zeus with Death and Hell.

Lister had won the battle that was to give us the surgery of today.

# 8

## *Charmed Bullets*

### PAUL EHRLICH, 1854–1915

Two miles above sea level, with only the thinnest, bluest air between them and the sun they worshiped, lived a remarkable people who established a wonderful way of life. A bright civilization flourished there while Europe was still floundering through the Dark Ages in horrible poverty and barbaric wealth, with famines wiping out the peasantry while the lords and ladies shrugged their shoulders, not realizing they would fall victim to the pestilence following in famine's wake.

No famines devastated the land in this South American country. Fertilized terraces clung to the sides of the Andes Mountains; irrigation had been developed; and it was the custom to store away food in good years for all to use if the crops should fail. Extreme poverty did not exist by the side of wealth. The sparkling gold that was mined from rich veins did not go into the pockets of individuals, but was used to adorn altars that were never soiled by the blood of human sacrifices. Roads had been

carved out of the mountains, and gorges spanned by wisps of bridges, to connect the far reaches of this land. The inhabitants were all kings, for this was the land of the Incas, and Inca means "king."

When the realm had grown so large as to make communication almost impossible, *the* Inca, as the leader was called, willed one part of it to his favorite son and the other part to his legitimate heir, who bitterly resented having to share his birthright.

While the half brothers were quarreling, Pizarro came. Through bravery and treachery and cruelty he conquered the Incas and won Peru for the King of Spain.

The greatest prize that fell into the hands of the Conquistadors was not the bright gold that inflamed their greed. It was a crumbly brown substance, the bark of certain South American evergreen trees. Not that the Spanish conquerors paid any attention to it — it was the Jesuit priests following the army who noticed the way the natives cured themselves of fevers by drinking a brew made from this bark. No one could say how long they had been using it, for no one remembered the first time one of them, shivering with chills and burning with fever, had sipped this bitter drink and risen from his bed again.

The Jesuits were tremendously impressed. Never before had they heard of anything that could help people suffering from such fevers, which they called *malaria,* the "bad air" disease. They were certain it was caused by bad air since people living near swamps and marshes usually suf-

fered from it, and one could see the fogs and vapors rising from the ground at night. It seemed obvious to them that these "miasmas," as they called them, were dangerous.*

Around 1632 the Jesuit Bernabé Cobo brought some of the bark back to the Old World, where it worked miracles. Two hundred years later two French chemists, Pelletier and Caventou, isolated the active ingredient of this bark. It was quinine, an alkaloid, a chemical compound that could save people suffering from malaria.

*Not until about fifty years ago was it discovered that the disease was spread by mosquitoes breeding in the swamps rather than by miasmas.

It was a long distance in time and space between the ancient Incas of Peru and Germany's Royal Institute for Experimental Therapy where, during the early years of the twentieth century, two men were engaged in searching for another chemical that would serve as a specific against a disease. The men were Dr. Ehrlich and Dr. Shiga, the institute's German-Jewish director and his Japanese assistant.

It was true that other chemicals besides quinine were used as medical remedies. Mercury, for example, had been employed for centuries in treating a number of ailments, including diseases of the skin. However, it was apt to make the patient's teeth drop out or to damage his kidneys if taken in sufficient quantities to be effective against the disease for which it was given. That was the trouble with chemical remedies: the cure was just about as dangerous as the illness—with the exception of quinine.

Other remedies might or might not be helpful in treating various diseases, but quinine was unique. Without quinine the victims of malaria were doomed to racking misery until death ended their suffering; with quinine, their chills and fevers stopped, and they could live fairly normal lives. It was like a glimpse of the age-old physicians' dream, the dream of a *therapia sterilisans magna,* a Great Sterilizer to kill diseases without injuring the patient.

In the early years of the twentieth century, Paul Ehrlich set out to find another piece of the great dream. He knew,

of course, that scientific physicians had long since given up thinking about the Great Sterilizer, just as they had stopped hunting for the mythical unicorn, with its life-saving horn, and the philosophers' stone, that would turn crude metal into gold. But it was the kind of idea that appealed to him. There was no concept so great, no idea so wild, that he couldn't find a spot for it in his mind, crowded as it was with large facts and small.

There was always room for more in Paul Ehrlich's mind, as there was always room for more on his desk, even though it was piled so high it looked as though a thousand small boys had emptied the contents of their pockets on it. The women who cleaned for him would long to tidy it, but he would frighten them off by saying there were poisons scattered about among the test tubes and papers. He, having taken the proper antidotes, was safe, but they had best beware. It was hard for them to tell whether this was one of the doctor's jokes; they had trouble understanding him anyway because he talked terribly fast and was always interrupting himself to make notes on anything he could lay his hands on because an idea had suddenly struck him. But they stayed away from his desk.

Visitors were usually shocked not only by Ehrlich's desk but by the way he let books and papers pile up on every chair and even on the floor, with barely a footpath left clear to walk through. "He must have an untidy mind," they said. Yet they said it kindly, for they couldn't help liking Paul Ehrlich. Even those who were certain

a man could not be a scientist if he was gay and amusing and disorderly had to admit that he was brilliant, hard-working and patient; in short, that he was a scientist.

Paul Ehrlich was nearing fifty when he began the search that most doctors would have considered a foolish waste of time.

Day after day he and Dr. Shiga injected aniline dyes into mice, into healthy white mice and into ones that were suffering from a disease called *mal de caderas* which was caused by a tiny parasite, a unicellular animal, the trypanosome. Trypanosomes, it had recently been discovered, were the cause of the deadly African sleeping sickness, carried by the tsetse fly.

Every mouse into which Ehrlich and Shiga injected trypanosomes (which they obtained by taking a drop of blood from an infected mouse) would, within two days, become very sick. The microscope would reveal swarms of trypanosomes in its blood — wriggling creatures, with flexible whips for noses and fins running along their bodies, boring away at the cells of the mouse's blood. (Trypanosome comes from the Greek words meaning "borer" and "body.") Without exception, every mouse into which trypanosomes had been injected died.

Ehrlich and Shiga injected aniline dyes into healthy mice and into sick ones, mice they were going to infect later and ones they would leave alone. Always they got the same results. The dye made the mice look very strange, for it colored their skin, which showed plainly through their thin fur, especially around the ears — but it did noth-

ing else. Trypanosomes killed dyed mice in the same way they killed white and gray ones. The dye did no harm and no good. Colored mice ran around the cages in the laboratory like animated blossoms, or drooped, sick and dying, like their plain companions.

Cheerfully Dr. Ehrlich offered suggestions and encouragement, trying to speak slowly and distinctly because he knew how hard it was for a foreigner to understand what he was saying; the only trouble was he would forget about that when he was excited — which was often. Another thing his assistants found disconcerting was his habit of singing, slightly off key, while he worked — especially when the man with the barrel organ, whom he encouraged to come around, was grinding out his favorite tunes under the laboratory window. It didn't bother Dr. Shiga, and neither, apparently, did the black cigars which Ehrlich used to smoke incessantly.

They kept on trying, for Ehrlich was certain he could find a chemical that would kill trypanosomes without injuring the mice. It was more than a hunch that made him choose this project when, as director of the institute, he could devote himself to any piece of research he cared to select. The idea had grown out of his past experience, starting with his student days.

He had always been interested in research rather than in the practice of medicine, having decided to become a doctor because he was fascinated by his college course in histology, the branch of biology dealing with the structure of tissues.

A cousin of his, a well-known chemist named Karl Weigert, had shown him how to stain tissues in order to make certain cells stand out more clearly under the microscope. One kind of cell would absorb a certain chemical dye, turning blue, while other cells would not be touched by it. A cell nucleus would absorb one dye, and the protoplasm another. This was fascinating to Paul Ehrlich, who wrote his medical-college thesis on the theory and practice of staining tissues.

The theory was the most important part to him, although he appreciated the usefulness of being able to stain tissues. He saw that certain cells were touched by specific dyes, which made for them as an arrow makes for its target. To other men this was no more than an interesting fact, but to Ehrlich it was a breath-taking concept — the concept that there was an affinity between certain cells and certain chemicals. He was not, in those days, prepared to investigate the possibilities of this idea, but he kept it in his mind.

He worked for some years on the practical aspects of tissue-staining. He found new ways to stain cells, including those of the blood, and this made it possible to learn a good deal about such disorders as anemia. When he found that the aniline dye called "methylene blue" stained the ends of nerve cells (and so helped doctors to study the nervous system), he reasoned that the dye might make the nerve endings less sensitive. Since the dye did not touch the other tissues of the body, he injected it into people suffering from neuralgia (nerve pains); it did not

harm anybody, and it often seemed to do some good. After Robert Koch discovered the tubercle bacillus in 1882, Ehrlich promptly found a dye to stain it and make it easier to detect.

Later he studied the toxins, both bacterial ones and vegetable poisons (which were easier to work with and to which the body reacts in a similar manner). The theories he formulated from this work were very important: among other things, they made it possible for Behring to produce diphtheria antitoxin in 1894.

Ehrlich was fascinated by the way the system creates antibodies in fighting a disease, and the way the antibodies attack the disease germs and often protect the body against further attacks of the same disease. It is as though the body creates charmed bullets which strike only those objects—the germs—for whose destruction they had been intended.

Since certain chemical dyes have an affinity for certain cells, he reasoned, why couldn't he find one that would act the way antibodies do? Why couldn't he create charmed bullets, made out of chemicals, which would strike only the cells that cause diseases and would leave the rest of the body untouched?

Even to conceive of such a thing required daring as well as knowledge and imagination. Paul Ehrlich, however, did not leave it as a theory.

He decided to try to find a magic bullet that would strike the trypanosomes, because they were a good disease-causing organism to work with. It had been shown at the

Pasteur Institute that trypanosomes could easily be transmitted from one animal to another, that tiny as they were, they were huge compared with most dangerous germs, and that they could be destroyed by injecting arsenic into the animals in whose blood they were flourishing — unfortunately, the animals themselves died from the arsenic soon afterward.

He decided to search for his magic bullet among the aniline dyes because he knew a great deal about them, including the fact that they were not injurious to the tissues of the body. There were so many of these dyes that he thought it reasonable to assume one of them must have an affinity for trypanosomes. The fact that there were so many of them also meant that he would have to make a great many experiments, but that did not discourage him at all.

He was certain that he and Dr. Shiga would succeed. All that it took to be a success in science, he used to say, were the "four G's" — *Geld, Geschick, Geduld,* and *Glück*, the German words for money, capability, patience, and luck. At the institute they had enough money to live on and to conduct their experiments with; they weren't lacking in brains or patience. So it was only a question of getting a lucky break. That could come any time. The thing to do was to keep on trying.

Noticing the way a lovely red dye called "benzopurpurin" colored the white mice into which they injected it, Ehrlich came to the conclusion that it was not soluble enough to penetrate all the tissues. He decided to modify

it so it would dissolve more easily. Although this was an obvious idea, most scientists would have rejected it because there would be practically no end to the things you could try once you started changing compounds around. The prospect did not alarm Paul Ehrlich and his co-worker.

They began a new set of experiments with the new compound — benzopurpurin to which some derivatives of sulphuric acid had been added. They chose two mice, both miserably sick. Into one of them they injected their new dye; the other they left to act as a control. At intervals they made their routine examinations of blood taken from the two sick mice.

And then the fourth G — luck — entered the picture. When Paul Ehrlich put his eye to the microscope to look at a drop of blood taken from the mouse they had dyed this new shade of red, he cried out in excitement. Always before there had been swarms of wriggling trypanosomes in the blood of infected mice, but this time — not a single trypanosome.

No one could have understood the stream of words he poured out as he looked through the microscope. But Shiga didn't have to understand them in order to know what had happened.

Together the two men ran over to the cage. Two sick mice had been there. Now one of them lay dead among the shavings and the other, the one they had injected with their new dye . . . While they watched, it perked up its bright red ears and began tending to its whiskers

with its tiny paws. Two mice had been doomed by the trypanosomes that had been shot into their blood. Now one of them lay dead, and the other was frisking about the cage.

"We've saved the life of a mouse!" Paul Ehrlich cried triumphantly.

Feverishly he and Shiga injected the new dye, which they called "trypan red," into healthy mice and then shot trypanosomes into them. The mice stayed well. They injected the dye into mice whose blood was teeming with trypanosomes. The mice recovered. Time after time.

"Wonderful! Magnificent!" Paul Ehrlich shouted repeatedly; and for once nobody could say his high spirits were carrying him away.

There it was, the first chemical cure ever to be created by man—for no man had made quinine; man had simply used the remedy which nature had created and hidden in the bark of the South American evergreen trees.

Ehrlich had not *found* something that worked; he had *made* it—slowly and clumsily, perhaps, but made it to order. He had taken a chemical compound and had changed it around until he got what he wanted: a charmed bullet that would hit the object at which he aimed it, the organism causing a disease, and would leave the rest of the body untouched.

Paul Ehrlich had revived the old dream of the Great Sterilizer.

Trypan red, the first disease-curing chemical compound created by man, turned out to be far from perfect.

It worked only on mice, and only on one kind of trypanosome; and even there it did not always work, because if a few trypanosomes survived the initial shot, they and their offspring would become immune to the dye. This did not discourage Paul Ehrlich; setbacks never did, and this one enabled him to learn a great deal about the way germs develop immunities. The important thing, anyway, was that he had proved his theory was sound.

He tried again, this time searching for a charmed bullet that would kill the spirochetes which cause a number of dreadful diseases. Arsenic would kill them, so he determined to make a compound of arsenic that would do its work without injuring the patient.

Time after time he tried, each time meeting with failure. A hundred failures, two hundred, six hundred. Six hundred and five different compounds of arsenic, and none of them worked. Still Paul Ehrlich cried cheerfully, "Geduld!" And on the six hundred and sixth try his patience was rewarded. *Glück* — luck — entered the picture again. It brought success and immortal fame to Dr. Paul Ehrlich, for he had found a remarkably effective treatment for syphilis and an absolutely miraculous cure for relapsing fever and for the tropical disease known as "yaws."

Scientists forgot that they had shaken their heads over the way Ehrlich wasted his time and his talents, and followed him into chemotherapy. They had some successes, but for years it seemed as though no chemical would ever be discovered that would strike the disease-

bearing organisms belonging to the large group called "bacteria." Then, in the 1930's, over a dozen years after Ehrlich's death, the sulfa drugs were developed, also from chemical dyes. Countless numbers of people suffering from scarlet fever, certain types of blood poisoning, or pneumonia were given sulfanilamide and recovered. For the sulfa drugs kill streptococci—like the bullets Paul Ehrlich dreamed about when he gave the world a new servant of medicine, chemotherapy: curing by means of chemistry.

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# 9

# *The Doctor Who Was Born That Way*

EARL R. CARLSON, 1897–

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WHEN Mrs. Carlson finished hemming the flounce, she folded it carefully and then pushed the sewing machine over to the kitchen wall. In the corner nearby stood the packing case in which the sewing machine had been shipped; now it was no longer a packing case but an apparatus resembling—on a small scale—the parallel bars in a gymnasium. Her husband had made it to help their little boy learn to walk.

She glanced about the kitchen, spotlessly clean as always, straightened the chairs about the center table and smoothed its bright table cover. Going over to the stove, she moved forward the coffeepot, automatically hefting it for a second to reassure herself that there was enough coffee in it for her guests.

Margaret Carlson looked forward to this little interlude for which, when things were going well, she could man-

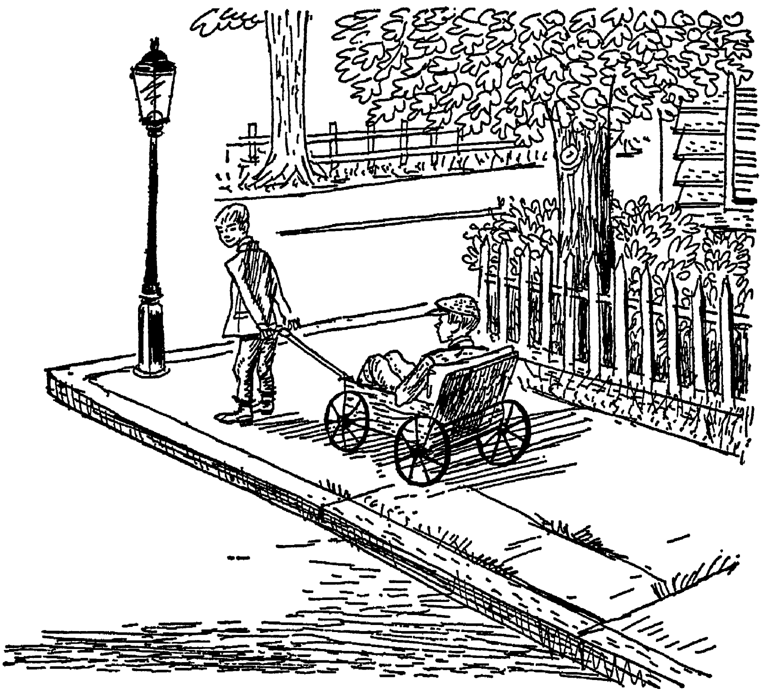
age to find a few minutes after a long, busy morning. Her husband was working full time now, so she had only Earl's midday meal and her own to prepare. In the afternoon she would return to the sewing with which she added to the family's income; later she would prepare the evening meal and help Earl clean up before his father came home. But now she could relax with her two friends who lived on the upper floors of the same tenement, and drink a cup of coffee made good and strong, in the Swedish manner.

She had told Earl, who was out playing with one of his friends, to come home when the noon whistle blew. She imagined they were playing horse, because he had asked her for a piece of string to use for reins.

"Ray says he's going to be the driver and I should be the horse because I have four legs," Earl had told her. He spoke quite distinctly, as he often did when he was alone with her, especially when he was so interested in what he was saying that he didn't worry about whether he could say it properly.

Four legs, she had thought, looking at the canes without which Earl could not walk at all. Aloud she said, like any other mother, "That's fine, as long as you're a good boy and stay out of mischief."

It seemed fair to her that Earl should be the horse, if only to make up for all the times his friends pulled him around in the gay wagon his father had made out of a box from the factory. She was glad they talked so frankly about his canes, and that he could talk about them too.



She was even glad when Raymond or Harold occasionally took advantage of him — when, called home by their mothers, they took away his canes to make certain he couldn't leave while they were gone. That meant they really liked playing with him and didn't just do it because they had been told to be nice to him since he was handicapped. She knew Earl understood that, too, although he would do things to get even with them when he had the chance. "Just like any little boy," she told herself. Standing in the bright kitchen that was also the Carlsons' living room and dining room, listening to the footsteps of her neighbors descending the rickety stairs, Earl's mother offered a quick prayer.

"Thank You, God, for all You've done for Earl. With Your help he's going to be just like other little boys."

Mrs. Carlson had offered that prayer over and over again, always with conviction, since the day her son was born. Everyone in Minneapolis still remembered that day, the day of the blizzard of March 25, 1897. The snow had come to the windowtops, and scarcely anyone had been able to get through the drifts the wind had piled up in the streets. But Margaret Carlson, awaiting her first baby, had not worried because the doctor would be delayed. Her own mother had not thought of having a doctor for her eleven children. When Margaret — the seventh daughter — was born, her mother had just finished milking the cow. She picked up her baby, who had landed in the milk pail, and took her into the house, where she cleaned her up and put her in the cradle. That was the way it was with peasant women in Sweden — and wasn't Margaret a strong Swedish woman, married to a husky Swedish man?

But something, she never knew what, went wrong; for when the doctor finally did reach their house the baby had not yet arrived. Her husband told her later that the doctor was very worried about her, and that when at last little Earl was born, he had scarcely been able to get the baby to breathe. He had used instruments to help bring Earl into the world, and they had damaged one eye and made a deep cut on his forehead.

Before long the doctor had to break the news to the

Carlsons that the brain of their baby—the only child they would ever have—had also been damaged. Earl was a spastic (a victim of what is now called cerebral palsy). He would never be able to walk or feed himself or talk properly. Perhaps, because it was difficult for him even to swallow, he might choke or die of starvation. The doctor spoke as tactfully as possible, but in his heart he did not expect the infant to develop mentally, either, and he wondered whether it would not have been better to let him die.

The Carlsons would have been terribly shocked at such a thought. They loved their baby, and they were grateful that he had been spared to them.

They did not grow discouraged even when, as the years passed and they took Earl from one clinic to another, they heard the doctors say he would always be that way. The doctors told the Carlsons that it was remarkable he had come along this far, that they must not hope for too much. But the doctors' words did not discourage Earl's parents. Each time they would say, "He's going to get even better; some day he'll be all right."

None of the mothers with whom Mrs. Carlson used to share a bench when she took Earl outdoors understood how she felt. "The poor little fellow," a newcomer to the group would remark. "What happened—did he have a sickness?"

"No, he was born that way," Margaret Carlson would answer in a matter-of-fact manner; and the others would start clucking sympathetically. She knew that Earl, who

was crawling about on the leather pads she had made to protect his hands and knees, understood everything they said. But they, certain he wasn't right in the head, would continue talking about him. How could she refuse the poor little fellow anything, they would ask. How could she even give him a spank when he was naughty, or make him struggle to do something for himself when she could do it for him so easily?

"Earl wants to be a good boy," she would explain, as much for his benefit as for theirs. "He knows I haven't time to wait on him hand and foot. I have to do my sewing, or how will we get along, especially if they start laying off at the factory again? Earl wants to do things for himself." Silently she would add, "And he's got to even though it would be easier for me if I did them for him — or what will happen to him if I should be taken away?"

She knew the answer to that: a home for imbeciles. She could understand why children like Earl might seem to be feeble-minded if their parents did everything for them. Children had to do things for themselves in order to learn. It was very hard for a child like Earl, because his muscles wouldn't do what he wanted them to; in fact they often did just the opposite, so that when he wanted to let go of something he might "freeze" onto it so tightly she could scarcely pry him loose from it. But that certainly didn't mean he wasn't bright.

She did not know that her conclusions were far in advance of those of the average doctor of her day. Many of them apparently never asked themselves whether or not

spastics might be retarded simply because they had been deprived of the opportunity to learn, either through neglect or misplaced kindness.

Some physicians did appreciate that fact, knowing that certain portions of the brain could be injured at birth without impairing the intelligence. They knew that a child who had difficulty in moving his hands and his lips had to be treated with skill and patience or he would never learn to feed himself or to talk. But the problem of training such children — and, more important, their parents and teachers — was more or less neglected.

Margaret Carlson did not have the benefit of scientific knowledge, but she had common sense and courage; she believed that Earl was bright and that she could help him to learn.

She was delighted when a doctor at the clinic of the University of Minnesota Medical School agreed with her that Earl had a good head on his ungainly body. In fact, he said, Earl could some day earn a living by his brains — factory work was out of the question for him — provided he could be given a good education. Unfortunately the doctor didn't tell her how Earl could get any education at all, but Mrs. Carlson knew what she would have to do as a beginning. She would have to persuade the public schools to accept her son.

She knew it wouldn't be easy. Even if she could convince the teachers that he was bright, they would say he couldn't keep up with the other children. It would take him forever to learn to write, when he couldn't hold a

pencil properly. And he was bound to disturb the others; often when he tried to pick something up he would send it flying through the air, so that he was always breaking things and causing a commotion. Nor was Earl a little angel; she would have trouble getting him to go to school, because being with strangers always made him worse. Well, those were problems she would have to face soon enough, so why worry about them in advance?

Now, sitting at her kitchen table with her two neighbors, Mrs. Carlson didn't think about her difficulties. They had finished their coffee, and she was doing something she particularly enjoyed — telling fortunes from the grounds left in the cups. Being the seventh daughter of a family of eleven, she was in great demand as a fortune-teller. She could easily have made money that way if her husband had not forbidden it.

His objections were not based on religious principles — she was the religious member of the family — but on the fact that he considered it wrong to make money by catering to ignorant superstitions. She was glad he didn't forbid her to tell fortunes for fun, for she knew he disapproved even of that. Maybe he was right, she used to think; but she could see no harm in giving her friends some pleasure. Luckily (for she would not have dreamed of cheating) the signs she saw in the tea leaves and the coffee grounds almost always indicated something good. Things had a way of looking bright to her.

"I see money," she said, tipping the cup into which she

was peering. "Someone close to you is going to come into money."

"Uncle Oscar! He's going to strike it rich at last."

Margaret Carlson frowned thoughtfully. "It looks more like a woman to me. See the bubbles—they're money—coming toward her."

The three women drew so close over the coffee cup that when the noon whistle shrilled its penetrating blast they started, bumping their heads together.

"That devil of a whistle!" one of them cried. "No wonder it frightens the horses out of their wits."

An instant later they heard the pounding of horses' hoofs on the street, and felt them shaking the old building. It had happened again! One of the teams of handsome horses that pulled the big brewery wagons had been stampeded by the blast.

The women ran to the front door, listening to the cries from the street. Luckily they were only cries of excitement, without the special urgency that would mean someone had been run over. Nevertheless Margaret Carlson could not relax until she knew her son was all right, for someone might bump into him in the confusion, and Earl could bruise himself badly when he fell.

Then she saw him. He was coming toward the house, lurching along with an awkward, scissorslike gait. To Margaret Carlson it was one of the most beautiful sights she had ever seen, for her little boy was walking by himself, without any support.

Catching sight of her in the doorway, he cried, "Ma,

Ray took my canes, and when the horses ran away, well, I was a horse so I ran away too!"

"That's fine, Earl," she called back, forcing herself to speak calmly for fear he would fall down; if she made too much fuss over something he did, he often wasn't able to do it any more.

But her neighbors couldn't control their excitement. "Why, he's walking without his canes! Look at him. It's a miracle — the boy's walking by himself."

Margaret Carlson gave thanks to God in her heart. Aloud she said in her gentle, pleasant manner, "No, it isn't really a miracle"; and she smiled at her son, her eyes paying him tribute. "It's the result of a lot of hard work."

Earl Carlson was never able to do easily the things that other people do without even being conscious of them — like walking and talking and handling a knife and fork. But with a great deal of hard work he managed to do them adequately.

By the time his parents died, he was able to earn money to finish putting himself through college. Earl Carlson could support himself by his brains, as a librarian. But that was not enough for him.

He had learned that there were a great many victims of cerebral palsy in the world, and that they were practically ignored by society and by medical science. They were still being sent to institutions for the feeble-minded, or hidden away in their homes by families that neglected or catered to them so that they failed to develop. His par-

ents had helped him to escape that fate. He determined to acquire the medical skill that would enable him to do far more for others than had been done for him.

No medical school wanted to accept him as a student because of his physical handicaps; but finally he managed to get one of the great ones to admit him — on trial. With the help of understanding friends, and by means of his own courage, humor, and intelligence, he surmounted the obstacles in his way. He not only became a doctor, but a world-famous one, lecturing and holding clinics in twenty-eight foreign countries as well as in almost every state of the United States. How he opened the door to other victims of cerebral palsy, so that they, too, could lead full and useful lives, is described in his inspiring autobiography, which he called *Born That Way.*

# 10

## *Not About a Frog*

GEORGE R. MINOT, 1885–1950

FREDERICK G. BANTING, 1891–1941

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THE doctor dreaded having to break the news to Joan's parents. He had known them all their lives, had taken care of Joan's mother when she was a girl, and of Joan since she was born. He was even more than their family physician—a neighbor and a friend whom they called "Dr. Jim" as though the title signified a relationship, like "Uncle." And now he would have to tell them that Joan, a lovely girl of fourteen and their only child, had pernicious anemia.

He had telephoned them to come over to his office. He hated to keep them in suspense; yet he did not want to tell them while they were at home. They would need time to pull themselves together before having to face Joan.

The moment they came into the room, whose old-fashioned furniture was looking particularly dark in the sharp, almost cold sunlight of a New England spring,

Joan's father asked, "Is it tuberculosis?" Dr. Jim's face had told him it was bad news, and that was the disease he particularly feared.

Dr. Jim assured him that there was nothing wrong with Joan's lungs, and that tuberculosis was not to be dreaded as it had been thirty years ago, when Joan's father was a boy and he himself just out of medical school. It had been called "consumption" then, and it had been almost invariably fatal; but now, in 1925, it could usually be arrested if it was diagnosed early enough. Unfortunately it made no difference how early one diagnosed pernicious anemia.

The doctor motioned them to sit down, and then, facing them across his crowded desk, he told them what Joan had.

"Pernicious — I suppose that means a very serious kind," Joan's father said.

Her mother added rapidly, as though she hoped to find protection behind a shower of words: "I was afraid she had something serious, she's so very pale. And I know we're going to have a hard time building her up. If only she weren't such a fussy eater. I do wish you could give her something that would improve her appetite — perhaps another tonic . . ." Her words ran out; and she paused for a moment before she asked him slowly, "What is pernicious anemia, Dr. Jim?"

He could not tell her that in this instance *pernicious* was a synonym for *deadly*. Instead he tried to keep his voice matter-of-fact as he described the difference between ordinary (secondary) anemia and the pernicious

variety. Both, he said, were due to a lack of red corpuscles in the blood. But in ordinary anemia the lack was scarcely more than a symptom, no matter how severe it might be — resulting from bleeding, or indicating an illness or a generally run-down condition; and it responded readily to treatment. Pernicious anemia was quite different. No one knew what caused it, but it was deep-seated; either the body could not manufacture red blood cells, or something destroyed them faster than they could be made. And the body had to have red cells, for, among other things, they carried the oxygen without which one could not live. Pernicious anemia did not respond to treatment.

Joan's parents understood. Each, quite unconsciously, reached for the other's hand, sitting there in silence except for the ticking of the old office clock and the sound of Dr. Jim's heavy breathing.

At last Joan's mother asked softly, "Will she have to suffer much?"

"No," said Dr. Jim, grateful for what little he could offer. "She'll tire easily, but when she's resting she'll feel pretty well. And of course we'll do everything we can. An iron tonic, and hydrochloric acid, which will help her digestion — her stomach doesn't provide it in sufficient quantity — and some arsenic to stimulate the bone marrow . . ."

"What's the good of that?" Joan's father demanded harshly; and Dr. Jim noticed with a shock that he suddenly looked old. "What's the good of that — what's the

good of you doctors, of medicine, if you can't save Joan?"

"Please, dear, it's not Dr. Jim's fault . . ."

Sympathetically Dr. Jim said, "That's all right, I understand. I think I realize, if anybody can, how you must feel. But you mustn't give up. The life expectancy of a pernicious anemia patient isn't usually very long, but I have known cases that kept going for fifteen or twenty years — and surely in that time . . . I know you remember the story — you must have read it to Joan when she was little — about the frog that fell into a jar of cream: even though the sides were so high he couldn't jump out, he kept on jumping and jumping just the same, until finally the cream turned to butter and formed a solid support for him. We doctors know this can happen in medicine: something can be discovered that changes the picture almost overnight. At this very moment work is going on that may bring results in time to save Joan. I know you want her to have that chance."

"Of course, of course. Forget what I said, Dr. Jim — we want you to do everything possible. Call in specialists, anything, no matter what it costs. I'll raise the money somehow."

"You know I'll do everything I can. But you'll have to do your part. The patient's mental attitude is very important in this kind of illness, and you'll have to keep up your spirits in order to be a help to Joan. No getting impatient, or letting her sense your disappointment — because there may be disappointments, you know. I can't promise anything."

"Just so we can hope," Joan's father said, taking a deep breath. And her mother added:

"We can always hope—and pray."

Dr. Jim felt he had been right in offering them some encouragement, although he was afraid Joan's chances were very slim. Comparatively few doctors considered it worth while to spend their time doing research on a condition like pernicious anemia, which had been labeled "hopeless" from the day it was identified.

For a time doctors had hoped that when people were unable to manufacture red blood cells they could be saved if good red blood from a healthy person could be injected into them—so all that would be necessary would be to improve techniques of transfusion until the procedure was safe. That had been accomplished. Doctors could safely pump blood into someone who had hemorrhaged until he was at the point of death, and watch him return to life before their very eyes. But it didn't work with victims of pernicious anemia. Transfusions did help; at least half the patients who received injections of healthy blood showed a marked improvement—but the effect did not last. In a series of almost fifty cases given repeated transfusions between the years 1914 and 1917, every one, even those that had responded most favorably, had terminated in death. Something in their blood seemed to dissolve not only their own red cells but those that were transfused into them.

Another thing that helped temporarily was removal of

the spleen; often the red-blood count went up right after that operation had been performed. But only for a little while, and then the patient grew paler and weaker and finally died.

Sometimes patients improved for no reason that anyone could put his finger on; and then, also for no reason, they went downhill again. Until doctors could find some clues as to what caused pernicious anemia, Dr. Jim didn't see how they could find a cure.

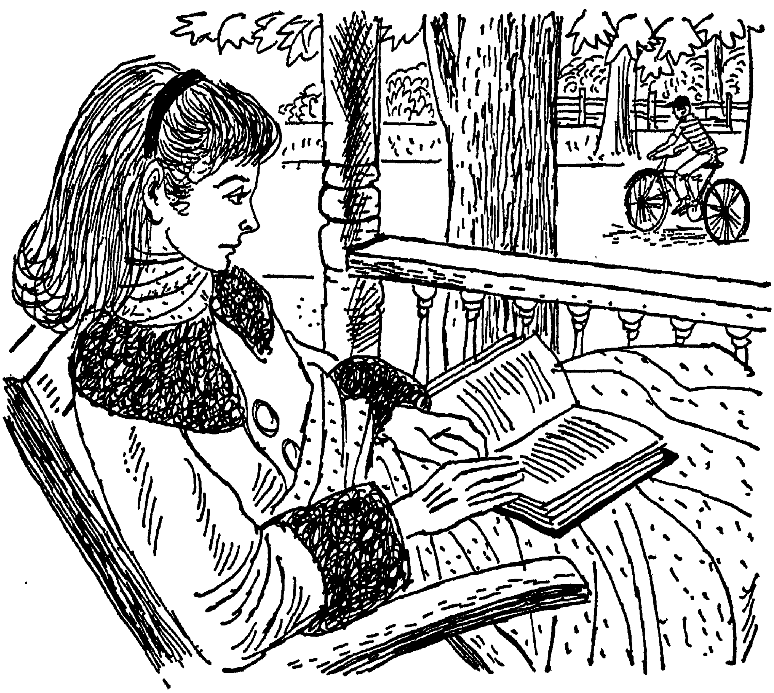
Each time he called on Joan, her parents would look at him with eyes from which the hope would fade immediately, as they saw from his face that he had not come with good news. They never asked him the question that meant so much to them, and there was nothing he could tell them.

He searched medical literature, going to the Boston Medical Library to look through journals he might otherwise miss, trying to find something, anything, that could provide a clue. There was so little time. He had feared from the first that Joan's case would not be one of the rare ones which he had mentioned to give her parents hope, in which the progress of the disease was very slow. But her condition was deteriorating even more rapidly than he had expected.

Each time he examined her blood, the red cells had decreased in number; each time he saw her, she was paler and more tired. Only a few months ago she had talked about what she would do when she was well again, and he had wondered how he could persuade her that she

should not go back to school. But Labor Day had passed without her even asking whether she could go; and though her friends came to see her and talked about the football games and high-school dances, she never said anything to indicate that she expected to take part in them again.

She was not ill. Seeing her bundled up in her deck chair on the porch, reading or watching the children riding their tricycles along the sidewalk, one would think she was convalescing from an illness. But she was growing steadily weaker. It would not be long, Dr. Jim knew, before he would have to start transfusions, which would



mean hospital bills and other expenses her family could scarcely afford — one transfusion after another, each one helping for a shorter and shorter time.

Desperately he went about asking questions, seeking out old colleagues he had not seen in years, and always receiving the same answer: "There is nothing, nothing new."

And then a rumor reached him — only a rumor, via the medical grapevine. One doctor told another that he had heard of some pernicious anemia patients in Boston who were responding remarkably well to a special diet. Dr. Jim did not dare to hope; yet he could not afford to pass over any possibility, however slim. He decided to track the rumor down.

He did not have to search very long, for in February a paper was presented to the Association of American Physicians. It was entitled "The Treatment of Pernicious Anemia by a Special Diet."

Dr. Jim was disappointed when he discovered that the special diet consisted of nothing more than a large serving of liver given to the patients every day. He had expected it to be based upon the principle of providing some basic element which the systems of pernicious anemia patients lacked — in the same way that victims of scurvy and pellagra were given food that had been missing from their diets. Liver could not possibly fall in that category since, according to Dr. Jim's estimation, the vast majority of the world's population never ate any liver, and suffered no ill effects.

Yet the report was convincing. A large number of patients whose condition had been far worse than Joan's had all improved, almost from the day they began to eat liver; and they had gone on improving steadily, while her strength had waned inexorably. Some of them now had blood counts that were practically normal. Dr. Jim would give a lot to see Joan's red cells increase like that.

The figures were completely convincing, and scarcely less so to Dr. Jim was the name of the man who presented the paper: Dr. George R. Minot. He knew who Dr. Minot was: a teacher at the Harvard Medical School from which he had been graduated, associate in medicine at the Peter Bent Brigham Hospital, consultant in diseases of the blood at the Massachusetts General Hospital, and head of a medical service at the Collis P. Huntington Memorial Hospital. Dr. Jim also knew of Dr. Minot's family. Every doctor in Massachusetts, everybody interested in the medical history of the commonwealth, had heard of his grandfather, Dr. James Jackson, one of the founders of the Massachusetts General Hospital and the author of *Letters to a Young Physician,* which Dr. Jim had read in his youth. Dr. Jim was just old-fashioned enough to believe that a doctor with Minot's background was bound to be sound and cautious.

Dr. George Minot, he learned, was a combination of the past and of the present: the past, when doctors studied their patients, noting their responses to the treatments which were developed by the trial-and-error method, more concerned with finding something that worked than

with discovering why it did; and the present, with its scientific methods of research. Minot used the most modern techniques to study blood chemistry and diseases of the blood; and he studied patients in the old-fashioned (and only) way, by asking them countless questions and observing them closely.

Adding up the things he had learned about individual pernicious anemia patients, Dr. Minot had discovered that many of them were, like Joan, fussy eaters. This made him turn his attention to diet. Here he assembled more general information, not precise enough to be called fact. For example, there was a great deal of pernicious anemia among people who lived in countries where dairy products were plentiful, which suggested the possibility that dairy products could cause pernicious anemia or (more likely) that people who consumed a great deal of milk and butter neglected to eat enough other foods, such as meat and vegetables. Even a little fresh meat and vegetables cured pellagra and scurvy practically overnight. Of course pernicious anemia wasn't cured that way, but it was such a slow sort of disease—he had never been able to find out when it first struck a patient—that perhaps it would respond very gradually to diet.

This was no more than an idea, but Dr. Minot could see no harm in telling one of his private patients to go easy on fats and starches and to eat plentifully of meat and fresh vegetables and fruit. Having read that the bones of lion cubs with rickets in the zoo were strengthened when they were fed liver, and knowing that bone marrow was in-

volved in making red blood cells, Dr. Minot told his patient to eat liver several times a week.

He was not impressed when the man began to feel better and his red blood cells increased a little, for those things happened sometimes, and the man was not very ill anyway. However, it certainly indicated that the diet was doing no harm, and so Dr. Minot suggested it to another, and great deal sicker, patient. When she, too, improved, he told them both to eat more liver.

He was a very busy man with a teaching and a hospital position in addition to his private practice, and he was engaged in research work on such blood diseases as leukemia, as well as pernicious anemia. He had no clue as to why liver helped; but as long as two patients were continuing to improve, he urged eight others, one after the other, to try it. He was not too busy to find ways of talking them into eating liver when they said they hated it.

They all got better. Common sense said it was because of the liver, but common sense is not science; nevertheless, Dr. Minot saw no reason for throwing it overboard on that account. The thing to do was to try liver on a number of hospital patients at the same time, in order to check on it, to make certain it wasn't something else his patients were doing—something he did not know about—that accounted for their improvement.

So he talked to young Dr. William P. Murphy, who was also interested in disorders of the blood, suggesting he try liver on the pernicious anemia patients at the Peter Bent

Brigham Hospital — but being careful not to say too much, because he wanted Murphy to have an open mind. Dr. Murphy went ahead, which was not as easy as it sounds, since hospital-cooked liver is nothing to tempt the appetites of sick people. However, he managed to get his patients to eat it, and they all improved. Both he and Dr. Minot felt that the time had come to report their findings.

Reading the report convinced Dr. Jim; yet he went to the Peter Bent Brigham Hospital to see for himself. The miracle he had scarcely dared hope for had come to pass.

Again he asked Joan's parents to come to his office, in case they should break down when they heard the news — but this time for joy. It was one of the moments in Dr. Jim's life when he could think of nothing more wonderful than to be a doctor.

At last they recovered their composure enough to go home, with a stop on the way at the butcher's to get some life-saving calves' liver for Joan's dinner. Dr. Jim promised to call on them as soon as he had finished with his other patients.

Looking forward to the happy scene he expected to witness, he was shocked when Joan's mother opened the door for him, for she appeared worried and distracted. As he raised his bushy eyebrows questioningly, she whispered, "Joan wouldn't eat the liver. She said she wasn't hungry and she doesn't like it anyway, and she'd never be able to keep it down. I couldn't get her to take it even when I ground some of it to a pulp and put it in orange

juice, the way you suggested, so she could just swallow it in a gulp."

"Well, now, this will never do!" cried Dr. Jim as he went into the living room where Joan was lying on the sofa. But when he saw her, he realized that she was too weak and exhausted to be buoyed up by a hearty manner. Her face was as waxen as that of an unpainted doll, and it was an effort for her to open her eyes and look at him. Apparently she had felt the excitement of her parents, and it had been too much for her.

"I guess you're pretty tired this evening," he said gently.

With a sigh, Joan let her eyelids droop again.

"Joanie dear," her mother pleaded. "Won't you try, for my sake? It'll do you so much good. Won't you make one more effort, like the frog in the story I told you about?"

Scarcely moving her lips, Joan said, "I don't see why the frog didn't just fold up his legs and go to sleep. It doesn't make any difference, when you're so tired."

Quickly Dr. Jim signaled to Joan's mother to leave the room as he said, "Let's not talk about that now." He was afraid Joan was going to cry, which would add to her exhaustion. Pulling over a chair, he let himself down into it adding, "I'll just sit here and rest before I run along. I've had a pretty tiring day myself."

Although he was careful not to show it, Dr. Jim was very much concerned about Joan's attitude. She was a good girl, and he could reason with her until she agreed to do as he asked. But in her condition it didn't take much to distress her, and an upset stomach that would not retain

the miracle-working liver was the thing he most wanted to avoid. Even now, with rescue in sight, a great many things could happen to a girl in Joan's weakened state: pneumonia, or one of the contagious diseases. Dr. Jim always worried when a patient seemed to be losing the will to live.

He must, he thought, find some way to arouse her interest and yet not upset and tire her, so that she would eat the liver because she wanted to get well rather than because she had been told to. It was his job to help sick and tired wills as well as sick bodies. Surely if Dr. Minot and Dr. Murphy could persuade their patients to eat liver, he should be able to figure out a way of reaching Joan.

He had been thinking about it for some time when Joan stirred restlessly, and he asked, "Do you remember the way I used to get you to be quiet when you were sick, by telling you one of my longwinded stories if you'd promise to listen closely so you could tell me the moral afterward? Would you like me to tell you one now?"

Joan smiled faintly. "All right, Dr. Jim. Just so it's not about that frog."

"It isn't about any kind of a frog," he assured her, smiling in his turn. He cleared his throat several times. Then he began by reminding her that he was not an accomplished storyteller; he never knew where to begin, or how to invent what people said to each other. So he wouldn't try to put any conversation into this story, but only to tell her the things that happened.

Because he had to begin somewhere, he said, he would

start with Frederick G. Banting. Banting was a young Canadian doctor, home from the World War, where he had almost lost an arm. Bone surgery was his specialty, but since he was having a hard time getting patients, he took a teaching position in a medical school in western Ontario. In order to do his job well, he read a lot of papers. One of them made a great impression on him.

It was a paper about some experiments in which, although the pancreatic duct had been blocked off and the cells of the pancreas had died, no diabetes had resulted. Certain cells lying on the pancreas, which are called the islands of Langerhans after the man who had discovered them, were flourishing. Hard as it might be for Joan to believe, Dr. Banting found this piece of information thrilling; and it gave him an idea.

Although he didn't know much about diabetes, Dr. Banting knew it was supposed to be caused by the failure of the pancreas to manufacture certain digestive juices — or, some people believed, a failure in the islands of Langerhans. The paper confirmed the theory that the trouble was, indeed, in the islands of Langerhans; and Banting's idea was that one could tie off the pancreatic duct, which would make the pancreas cells die but leave the island cells flourishing, so that an extract could be made of them.

This was the kind of idea that comes to lots of young doctors, who plan to talk it over with somebody who knows more than they do; then they forget about it in the morning. Banting certainly was no authority on the sub-

ject, but he didn't forget about it. He was the kind who stuck to things — especially when they might cast some light on a terrible disease like diabetes.

At that time, Dr. Jim explained, there was scarcely anything worse that could happen, especially to a young person, than to get diabetes. People who had it could not assimilate sugar (or starch, which the body breaks down into sugar), and so their systems would eliminate the sugar. When there was too much to eliminate, it got into the blood, where it caused a great deal of damage — eventually sending its victims into a coma from which they would not awaken.

A diabetic person, therefore, had to avoid eating anything with starch or sugar in it, which was very difficult as there are few starch- and sugar-free foods. Besides, the system needs sugar for energy, and in order to help in the "burning" of fats. The diet wasn't too bad for old people, who didn't need to eat very much, or for people who had a light case of diabetes; but it simply wasn't possible for young people to grow or even to live very long on a strict diabetic diet. They faced slow starvation and the danger of sugar piling up disastrously in their blood. But if Fred Banting could make an extract from the islands of Langerhans that might take care of the sugar —

He told his idea to the professor of physiology at Toronto, who wasn't very much impressed because vague ideas are a dime a dozen around medical colleges, and Banting didn't know enough about the subject to express himself clearly. But Banting was serious, and the professor

knew seriousness was something worth encouraging. So he granted the young surgeon's request for some dogs to experiment on and an assistant and a place to work for a couple of months in the summer.

As soon as Banting finished his teaching term, he started his experiments with the help of a twenty-one-year-old medical student named Charles H. Best, who got the job by tossing a coin for it. When their eight weeks ended in the summer of 1921, the two young men couldn't have convinced anybody but themselves that they were on the right track. But fortunately it was summer, so nobody paid much attention when they didn't stop working. Of course nobody gave them anything either, and it took all their ingenuity to wangle supplies for their work, to say nothing of managing to exist themselves.

But they didn't care, because they had tied off pancreatic ducts, had done all kinds of things, and had finally got an extract which, when they injected it into a dog that was at the point of death from diabetes, brought the animal back to life. Only for a day, but for that one day the blood sugar of a dog without a pancreas had been brought back almost to normal. Banting and Best were positive it would not be long before they could work out a better process for getting the precious extract, which they called "isletin" after the islands from which they obtained it.

The trouble was that they could get so little of it, and only with a great deal of difficulty, from a dog. And then they learned that the pancreas of an embryo calf is rich with the precious islands. That simplified everything.

All they had to do was go to a slaughterhouse and ask for the pancreases of unborn calves and make an extract from them. It worked miracles—on dogs. When Banting and Best tried it on themselves, it didn't do them any harm. And so they tried it on a friend of Fred Banting's, a young diabetic doctor who was so close to death despite his starvation diet that people wondered why he didn't go ahead and eat a good meal and let himself slip into the coma that was bound to get him anyway. One shot of the extract and Banting's friend felt well for the first time in years. But the next day he felt awful again, and there was nothing they could do about it because they had no more isletin. Only now Fred Banting's friend had a good reason for hanging on.

By that time, of course, Banting and Best had lots of help from the professor who had granted the request of a young man with nothing but earnestness to recommend him. Their precious extract was improved and renamed "insulin" and made in greater and greater quantities. It saved the life of Fred Banting's friend, and then of other patients who were just as sick as he.

Nobody any longer had to die of diabetes. No more starvation, and sugar piling up in the blood. No more being hungry and feeling miserable and knowing a coma was hovering near. All diabetics had to do to be well and healthy was to have an injection of something their bodies needed and couldn't manufacture—an injection so easy to give they could do it themselves, even those of them who were children. It was inconvenient, but not any more

so than, for example, wearing glasses; and it made them well. Diabetics could now lead normal, useful lives.

Dr. Jim couldn't even begin to know what each of them did with the life that insulin had saved, or in what way each affected other people. It was too much even to guess about. But he did know a little about what one man did with his life, and he wanted to tell that as the last part of his story.

The man was a doctor. He had a home and family and work that he loved, important work that was just beginning to bring results. It was concerned with patients who were doomed to die because something in their bodies failed to do its work. And then something in his body failed, and his blood began to get sugary. He had diabetes. Being a doctor, he knew that he was young enough so that his prospects were not good. Nevertheless, he went on a strict diet and he stuck to it, and he went on working as though he had a long, active future ahead of him. He had no way of knowing that the very same year he made the tests that told him he had diabetes a young Canadian doctor had gotten a bright idea about the islands of Langerhans.

He was hungry and tired and he didn't feel well, but he worked hard, not for himself but for the people whose blood was failing them in a different way. The miracle of insulin came just in time. Without it he might not have been able to continue his work, but with it Dr. George R. Minot was restored to health.

With a new vigor he attacked the problem he was try-

ing to solve; and he found the answer. Because of his discovery, people would not have to die from a lack of red cells in their blood, any more than diabetics would have to die, now, from too much sugar in theirs. The families of people with pernicious anemia would not have to lose the ones they loved; another group of children could grow up to lead lives that would touch the lives of nobody knew how many other people, with results no one could anticipate.

"That isn't the end of the story," said Dr. Jim. "It really hasn't any end. But I've got to stop somewhere, and it might as well be here."

Anxiously he wondered whether he had been able to reach Joan. How could he expect to communicate to her his feeling of joy because two great battles had been won and there would be living instead of dying? How could he hope she would understand that this was more to him than an account of what a few men had accomplished? It contained what he felt was in a sense the meaning, the essence, of life—a fragment of the pattern in which each individual is an important thread, the entire pattern enriched and brightened by those far-reaching threads that are the individuals who value their own lives, and the lives of others? How could he, an elderly family physician, hope to tell a story so it would mean all that, and more, to a sick girl of fifteen?

"Now it's your turn, Joan," he said as her eyes opened. "Do you know why I told you this story?"

"I think so, Dr. Jim. For the same reason you used to

tell me stories when I was a little girl; so I'd be good and take my medicine."

He thought that he had reached her, because her voice was different. It was as weak as ever, but the dullness, the apathy, had gone; and while her pale lips did not smile, their corners no longer drooped.

"But you wanted me to tell you what I thought the point of the story was," she went on, hesitating for a moment before she added, "Is this it, Dr. Jim: we're not frogs, we're people, and so it *does* make a difference?"

"Why yes," said Dr. Jim happily. "That *is* the point of the story."

Joan did not have to eat liver very long, because other scientists found out exactly what it was that people with pernicious anemia needed in order to have healthy red blood cells. What they needed was in liver, but it could usually be supplied by injections.

What Joan did with her life is not known. It isn't, really, known whether there ever was a sick and tired girl by the name of Joan. But if there was, her life became an important part of the pattern, for that is what happens when anyone feels that life is well worth living.

# 11

## *The Accident*

ALEXANDER FLEMING, 1881–

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ALEXANDER FLEMING was born in England in 1881. And in the same year the English physicist John Tyndall published a book entitled *Essays on the Floating-Matter in the Air.*

No one, aside from the Flemings' relatives and friends, considered Alexander's birth important. And the book was of interest only to scientists concerned with Pasteur's theory that putrefaction and infection are caused by germs.

Microbes (the name comes from the Greek words meaning "small" and "life") were a familiar sight to scientists who used the microscope; they were usually dismissed as too small to bother about. It was also generally assumed that they created themselves, by a process called "spontaneous generation." Pasteur, however, insisted that there was no such thing as spontaneous generation, that all microbes were descended from similar microbes. Where did they come from? From everywhere, Pasteur

answered, for they were easily transported, were even floating in the air. If they happened to land on something that offered them nourishment, they grew and multiplied rapidly; and while a single microbe was, indeed, too small to amount to anything, a whole army of them was a different proposition.

A number of reputable scientists said Pasteur was talking nonsense. Some of them still believed that a horsehair left overnight in a pool of rain water would turn into a snake, and that eels created themselves from mutton gravy. Others, more advanced, agreed that the larger creatures had to have parents, but insisted that tiny microbes came into existence when certain molecules happened to meet and join themselves together.

When these men repeated Pasteur's experiments in a haphazard manner, they failed to get his results. This strengthened the hands of Pasteur's opponents and raised some doubts in the minds of those who were inclined to believe in his germ theory.

John Tyndall decided it was time for him to step in. His own experiments would carry considerable weight, for he was recognized as a sound and thorough scientist, a Fellow of the Royal Society and professor of natural philosophy at the Royal Institute.

It was true that microbes were not exactly in his line; his investigations were concerned with such subjects as light, sound, gases, radiant heat, and magnetic waves. Yet he was a man of wide interests, and besides, the study of germs did not actually fall in any particular field.

Tyndall's experiments were carefully performed. After making certain they were free of germs, he set out flasks containing jellies and broths (infusions) on which microbes could grow. Some flasks were made to admit air but keep out dust and other particles that might be floating in it: they had long necks that were curved and bent so that any particles would settle in them before reaching the food. The substances in these flasks did not spoil or turn sour or decay.

On the other hand, the material in flasks left open to the dust grew cloudy, decayed and putrified. Examining it under his microscope, Tyndall could see various tiny organisms—fernlike fungus growths known as molds, such as one finds on cheese or on bread that has become moldy. He also saw rod-shaped and corkscrew organisms called bacteria. Tyndall found microbes in the air of all the rooms in the Royal Institute in which he placed his flasks; there appeared to be more microbes in some rooms than in others, and they seemed to thrive better on certain of his foods. But there was no doubt about it; they did float in the air, and they were the cause of decay. Pasteur was right, and so was Lister when he said that wound infections were due to tiny organisms.

Tyndall observed and recorded a number of things in his *Essays*. For example, he mentioned a flask of mutton broth in which bacteria were growing: a speck of mold drifted onto it, making a characteristic spot on the surface. Tyndall, familiar with the classifications of molds, recognized it as belonging to the *Penicillium* group. It was not

at all unusual for molds to form on the surface of the foods in the flasks. Usually the bacteria went right on growing too—but not always.

Tyndall wrote: "The mutton in the study gathered over it a thick blanket of *Penicillium*. On the 13th it had assumed a light brown color, as if by a faint admixture of clay, but the infusion became transparent. The 'clay' here was the slime of dormant or dead *Bacteria*, the cause of their quiescence being the blanket of *Penicillium*. In every case where the mould was thick and coherent the *Bacteria* died, or became dormant, and fell to the bottom as a sediment . . . The turnip-infusion, after developing in the first instance its myriad-fold Bacterial life, frequently contracts mould, which stifles the *Bacteria* and clears the liquid all the way between the sediment and the scum."

Nobody, including Tyndall, considered this an important observation. It was merely one of many things he happened to mention.

Later, when the study of germs had become a science and was called "bacteriology," no one bothered much about Tyndall's book which—valuable as it had been at the time—had been intended to prove a few basic facts which everyone had come to accept.

Bacteriology made rapid advances. One after another, the organisms causing various diseases were identified. A number of them could be rendered harmless to people and animals by a method Pasteur discovered. He called it "inoculation by means of an attenuated virus"—mean-

ing, the injection of an old, weak strain of bacteria which, while causing little or no discomfort, made the body immune to the same bacteria even in their strongest state.*

A great many dangerous microbes could not, however, be conquered in that manner. Paul Ehrlich had found charmed bullets to strike down certain of them. But a large group of germs still continued to cause diseases and death. No chemicals had been found to kill bacteria without injuring the tissues, especially the leucocytes (white blood cells) which are the body's most valuable fighters against infections.

Among the many scientists who were searching for a safe way to kill these organisms was Alexander Fleming, who was a doctor and bacteriologist. During World War I he was assigned to the task of trying to find a better antiseptic for the wounds of battle casualties. After the war he married and resumed his teaching of bacteriology at Saint Mary's in London, adding a medical practice and continuing his independent research.

He worked with an assistant or two in his own small laboratory at Saint Mary's. This method of research was rapidly becoming obsolete. Bacteriology, like other sciences, had grown so complex it required expensive equipment, technicians to handle details, the division of effort, and the pooling of results.

It was generally agreed that men like Dr. Fleming,

*This is the principle involved in the inoculations given to prevent many diseases today.

working on their own, might be able to make minor contributions, but no more than that. Yet people who knew Alexander Fleming could understand his choosing to work that way. He was mild and unassuming, a "homemade" kind of person, who would seem out of place in a big, streamlined project; and besides, he had probably inherited a liking for being on his own from his Scottish father.

Alexander Fleming went along in his own way, continuing to search for a good, safe antiseptic. He thought he might be on the track when he discovered an enzyme (lysozyme) in human tears and saliva which actually killed germs. Unfortunately, however, the only ones it killed were those that were harmless or even helpful to the body.

In the fall of 1928 he was studying some of the most dangerous of the bacteria, the staphylococci, which cause boils and carbuncles and some forms of blood poisoning. Dr. Fleming kept varying the conditions under which he grew these berry-shaped bacteria; for certain of their characteristics altered according to the temperature, amount of oxygen, and medium (food) on which they developed. So far he had not been able to affect their most important characteristic, their power to kill.

One day as he was about to remove the glass cover from a dish on which he had seen milky-looking colonies of "staph" (these bacteria grow in groups or colonies), he noticed that it had become contaminated. (In order to study a certain organism, scientists need to grow pure

cultures, containing only that organism. Yet despite their care, other organisms sometimes get onto the culture dish and start growing. Molds are frequent offenders, for there are a great many of them floating in the air. They get in the way and make it impossible to study the selected organism.)

Like countless bacteriologists before him, Alexander Fleming frowned in annoyance as he prepared to dispose of the culture which had become contaminated by a spot of mold—in this case, the mold known as *Penicillium notatum*.

And then he hesitated. No one, not even Alexander Fleming, can explain why.

Could it be that the spirit of John Tyndall tugged at his elbow, begging him to look carefully before he threw away the culture? Could Tyndall's spirit have whispered, "There it is, what I observed the year that you were born. I couldn't know how important it was; but you will know—if only you don't ignore it as so many others have done."

Alexander Fleming looked at the culture dish. Around the spot of mold he saw a halo of clear fluid. Clear fluid, not the milky-white one saw when colonies of staph were growing.

"It was astonishing," he wrote later, "that for some considerable distance around the mould growth the staphylococcal colonies were undergoing lysis [dissolving]. What had been a well-grown colony was now a faint shadow of its former self. I was sufficiently interested to pursue the

subject. The appearance of the culture plate was such that I thought it should not be neglected."

The spirit of John Tyndall must have sighed in relief as Alexander Fleming decided not to neglect this astonishing circumstance.

Fleming found that where the mold *Penicillium notatum* grew, staphylococci did not. Where they were already growing, the mold took over and crowded them out. It did not actually appear to kill them, but rather to prevent their growing and multiplying, so that they simply lived out their short lives and died.

What was there about this mold that the staph could not endure? Fleming filtered off some of the broth on which the mold had been growing and dropped it onto a thriving colony of staph; within a few hours they were fading.

This meant that the discovery had real possibilities as far as human beings were concerned, for while no one could grow mold in the blood stream of people who were being poisoned by staphylococci, one could inject the broth — provided, of course, that it was not harmful to human tissues.

Fleming discovered that it was harmless, at least in the test tube; it had no effect on white blood cells. He also discovered that it had no effect on a group of bacteria known as Gram-negatives because of their reaction to a staining test called the Gram test. (This was no surprise to John Tyndall, who had written, "The *Bacteria* which

manufacture a green pigment appear to be uniformly victorious in their fight with the *Penicillium*.")

Fleming called the broth that he distilled "penicillin." Everyone agreed that his discovery was interesting — very interesting — but not practical. It took a long time to obtain enough of this penicillin even to make a few experiments in a little test tube, and forever to obtain the gallons required to treat a single person. It was also hard to obtain, being easily ruined by heat or acids or alkalies.

The spirit of John Tyndall must have worried during these days. Would another fifty years have to pass before anything was done about the power of *Penicillium?*

Then a group of scientists, including Dr. Howard Florey and Dr. Ernst Chain, became interested. They worked for years, with the help of Dr. Florey's wife, who was also a doctor. She made great contributions to the clinical side of the project — the part connected with the use of penicillin on patients. This was the heartbreaking part; for though each time the doctors gave penicillin it seemed to do a lot of good, the supply would always run out, and then the patient would die. At last, however, enough of it was obtained to prove it could save lives.

The problem of manufacturing penicillin still had to be solved. By this time Great Britain was involved in World War II and was unable to tackle so difficult a project. The United States took over; and fourteen years after Fleming's discovery — in 1942 — the drug was made available to doctors.

It performed miracles. A dying woman was given an injection of penicillin, and immediately the deadly golden germs of *Staphylococcus aureus* vanished from her blood. A boy with subacute bacterial endocarditis, whose heart was being destroyed by the poisonous germs, was quickly restored to health. The pneumococci, clogging the lungs of a patient with what doctors agreed was a fatal case of pneumonia, melted away when he was given a shot of penicillin. Gas gangrene and tetanus germs were made powerless to kill the soldiers into whose wounds they had crept on the battlefields. Streptococci were also routed, bringing relief to victims of "strep throat," scarlet fever, and certain kinds of blood poisoning.

It was beyond belief, doctors said, what this wonder drug could do. It was a miracle, people said, as penicillin saved lives, put sick people back on their feet almost overnight, robbed one disease after another of its terror. And penicillin was not the only miracle drug. Other types of molds were investigated, and they produced antibiotics which fight the germs penicillin does not touch. A whole new era in medicine came into existence, all because an accident befell Alexander Fleming in his simple laboratory.

It was an accident—but one that had been happening for years. It was the kind of accident Louis Pasteur had in mind when he said, "In the field of science, chance only favors the mind that is prepared."

No doubt the spirit of John Tyndall heartily agrees.

# 12

## *The Precious Gift*

### CHARLES R. DREW, 1904–1950

Dr. Charles R. Drew, Medical Supervisor of Blood for Britain — the project for supplying blood plasma to Great Britain — paused for a moment to look in on the first, important step of the undertaking, the giving of blood. No project of this kind had ever before been attempted; it would serve as a model for other cities that wished to follow New York's example, and also, with modifications, for the armed services and hospitals. Dr. Drew was constantly on the alert for ways to improve techniques.

The blood-donor he was watching lay on his back on a cot, his face turned to the right, his left arm extended. It was connected by a tube to a bottle, half filled with sodium citrate solution, standing on a little table by his head. He was a robust man; and although Dr. Drew could not see his face, he assumed that he must be about middle age, because of his thinning, graying hair — "Conserva-

tive and well-to-do," the doctor added to himself, glancing at the man's expensive shoes and trousers and shirt.

"Everything's all right, isn't it?" the man asked as the nurse came over to him, his voice a shade too casual. Dr. Drew could imagine the way he had awaited the introduction of the needle into his vein, — as though he were in a dentist's chair. The attending doctor, cleaning the skin on the inner side of the elbow with iodine and alcohol, had probably said, "I'm going to inject some Novocain so the skin will be numb when I use the large needle; this needle is so small it will just prick a little." Dr. Drew could picture the donor's wary expression changing to a slightly incredulous one as the large needle had slipped painlessly into the vein; and perhaps he had asked, as donors so often did, "Is that all?" (The doctors were all skillful in finding the veins; if, as sometimes happened, a donor's veins were not accessible, the donation was refused, for, in line with the decision to prevent any unpleasant experiences, doctors were not permitted to make even a small incision to expose a vein.)

"Everything's just fine, Mr. Osgood," said the nurse. "I was going to suggest, though, that you close your hand a little tighter when you clench your fist. That'll speed things up a bit, and we don't want to keep you away from the office any longer than we have to."

"Like this?" asked Mr. Osgood, and Dr. Drew noticed the blood flow more rapidly into the bottle as the man's arm muscles contracted.

"That's perfect, Mr. Osgood. A nice steady rhythm does it."

The nurse's manner, Dr. Drew observed, was excellent — as was that of all the nurses and doctors, who were volunteering their services. They were matter-of-fact, as though this was a simple, routine affair, as indeed it was; yet they conveyed the impression that the donors were doing something important and admirable, which was also true. It was essential to treat the donors properly, for no stirring appeals for volunteers could be so effective as word-of-mouth reports by those who had given blood without finding the process at all unpleasant.

Dr. Drew was delighted with the way this portion of the program was working. Aside from a few donors who had fainted, undoubtedly for psychological reasons, there had been no untoward incidents. A follow-up of some of the first donors had shown that, while some of them had reported being a little tired, others had said they felt better than they did before giving blood. These results confirmed the wisdom of establishing age limits and making careful physical examinations — including temperature, hemoglobin and blood-pressure tests — to be certain a donor would not be injured by giving a pint of his blood, which is about one tenth of the body's total supply.

The response of volunteers was more than gratifying. The first blood had been collected from doctors and nurses at the Presbyterian Hospital (followed, a day later, by Mount Sinai Hospital) on August 16, 1940, the day the

bombing of London had begun. Within a month, mainly because of appeals to churches, synagogues, clubs and other organizations, 1723 people had given blood. Early in September the aerial blitzkrieg against London had begun, and by October 26 there had been 8699 donors. And the number was steadily increasing.

This was excellent, but it increased the problems of the project and its director. More workers were needed to take the blood, to make the bacteriological and other tests, to separate the red and white cells from the plasma, to test again, dilute with saline solution, bottle, pack and ship. Each step was crammed with questions that had to be answered.

Which was safest, most effective and most practical—whole blood, serum, or plasma? Once plasma was decided upon, should it be dried or sent in fluid form? (While the means of drying it were being perfected, it was sent as a fluid, diluted with a saline solution to prevent clotting, even though this almost doubled the bulk.) Should the white and red cells be removed by the slow method of letting them settle to the bottom, or by the faster—and far more expensive—method of using a centrifuge, which, like a cream separator, divides the heavy cells from the lighter, amber-colored liquid? What were the best methods of testing for infected blood before pooling it, and afterward of making certain an entire batch had not become contaminated? What kind of flasks should be used, taking into consideration the amount of air space, and absorption, the durability, the price, and

shipping problems? How should work places and laboratories be set up and run in the eight co-operating hospitals?

These and many, many other questions had to be answered, while the need for sending England a large quantity of safe plasma as rapidly as possible was kept uppermost. Yet at the same time decisions must not prevent change in line with new techniques and discoveries. Rapid as the advances were, Dr. Charles Drew, who was a research scientist as well as a surgeon, mourned because he could not, conscientiously, use the time or blood to investigate all the possibilities of this tremendous project.

The nurse was speaking; and Dr. Drew turned his attention to her. "I see we're just about finished, Mr. Osgood," she said. She slipped the tube from the flask to a smaller container fastened to it; the first testing would be made from this sample in order to avoid disturbing the contents of the flask. "Just lie still a few more minutes, please."

Mr. Osgood was apparently not inclined to follow instructions. No sooner had the needle been removed from his arm and adhesive tape applied over the tiny wound than he sat up and turned his head so he could see the flask, which the nurse was about to place in its rack. "Well, what do you know, did I give all that?" he asked. The question began in a booming voice, but toward the middle it began to trail off. The color drained from his face; and the nurse, who had quickly put down the bottle, caught him as he was about to fall back, and eased his

head onto the cot again. Without appearing to hurry, the doctor brought smelling salts. In a moment the donor was feeling better, although it took a little time and tact to help him recover from his chagrin.

"I don't know what got into me," he said sheepishly. "I never passed out in my life. Why, this girl who works in our office, she gave blood the other day and it didn't bother her a bit, and she's only a youngster."

"I'm afraid you sat up a little too suddenly. And besides," the nurse told him, "it's often the biggest and huskiest men who get upset at the sight of blood. We had one in here the other day who was on last year's All-American football team, and he fainted dead away."

It was difficult for Dr. Drew to realize how many people reacted with horror to the very thought of blood. It showed how long emotional responses to superstitions could persist, for surely there was nothing repulsive about blood itself. Personally he found it fascinating: its physical and chemical composition; the way it wound its intricate course through the entire body in about a minute, carrying its red cells with their essential oxygen to all the tissues; the way the white cells and plasma protected the body against infection; and the way, not yet completely understood, it turned from a liquid into a solid, a process known as clotting.

Yet despite all that is known about the blood, superstitions persist. "It's in his blood to act that way," people

remark. They say, "There's good" — or bad — "blood in that family," or explain differences between people by the differences in their blood.

It is true that the blood of all individuals is not alike. There are four different types, and the differences can be very important; but they have nothing to do with so-called racial, religious, or national groupings. Each of the four blood types includes people of all colors and nationalities. The blood of a Norwegian can differ from that of his own relatives and "match" that of a Chinese or an Indian.

It was strange, Dr. Drew thought, that people could know this scientific fact and yet continue to talk about "Jewish blood" or "colored blood." He fully realized that a great many of his fellow Americans would be reluctant to accept a transfusion of his own blood, because he was a Negro.

The existence of the four blood types had been discovered by Dr. Karl Landsteiner in 1906, winning him the Nobel Prize. He showed that the serious, often fatal, reactions following transfusions — which made the process too dangerous to be practical — were due to the fact that certain types of blood were "incompatible" with each other. The red cells of certain types of blood, meeting blood of other types, would form into clumps. This was extremely dangerous to the person in whose veins the cells were clumped (agglutinated). The wrong type of human blood could be as bad for him as the blood of an animal.

However, one of the four types, known as "O," never

causes clumping, and people belonging to this group are called "universal donors" because their blood can safely be given to anyone. As O is the largest of the four groups, a universal donor would often by chance be selected for a transfusion; and this accounted for the success of some of the early experiments. And, also by luck, the blood type of the person giving the transfusion sometimes happened to match — be compatible with — that of the person receiving it.

This was, of course, too serious a matter to leave to chance; and there was no way to tell what type of blood an individual had from his appearance or his ancestry. Fortunately doctors learned how to "type" blood from a sample; and then they could give transfusions without using types that were incompatible.

Yet in an emergency, the amount of time it took to type blood made a great deal of difference. Also, when a great many people were injured at the same time, as in a battle or a civilian disaster, it was almost impossible to take and type blood from enough donors to supply the demand.

Ways were sought to meet these problems. "Blood banks" of refrigerated type O blood were used during the Spanish Civil War, and by the Russians in peacetime.

Before that, during the First World War, a British army doctor had the idea that most of the benefit derived from transfusions was in the liquid part, known as "plasma." Ten years later Dr. Max Strumpia, of Pennsylvania, proved that this was so, and that plasma was more practi-

cal in most cases. Being free of cells, it could not cause any clumping, and so it did not have to be typed.

As a surgeon, Dr. Drew was particularly interested in transfusions as a means of preventing and treating the condition known as shock. Often, following a serious operation or injury — or a number of minor injuries — a patient's blood pressure would drop, his pulse become weak and thready, his skin turn cold and clammy, and he would collapse and perhaps die. This was apparently due to a diminishing of the fluid content of the blood, either from bleeding or from a seepage into the injured tissues.

A transfusion would work wonders in such cases. It seemed to be an answer to this surgical problem, which was scarcely less important than the problems solved by Paré, Morton, and Lister.

In 1938 Charles Drew was engaged in blood research as a General Education Fellow in Surgery at Columbia University, serving also as resident in surgery at the Presbyterian Hospital. He had received his bachelor's degree from Amherst, and his M.D. from McGill in Montreal; afterward he returned to Washington, D. C. — where in 1904 he had been born — devoting himself to surgery at Howard University. Under Dr. John Scudder he studied the chemistry and the fluid balance of the blood, and blood transfusions. His thesis for his second medical degree, the graduate one of Medical Doctor of Science, was *Banked Blood,* published in June of 1940.

There could have been no more timely subject. World War II had broken out, and the belligerent nations, recog-

nizing the importance of giving immediate transfusions to the wounded, had established mobile units to collect blood, and others to give transfusions where they were needed.

The British lost most of their units in the retreat at Dunkerque. Their situation was critical, as was that of France and of the Low Countries. Limited, though welcome, amounts of serum and plasma were sent from Canada, where the project was under the direction of Dr. Charles H. Best, who, as a medical student, had been co-discoverer of insulin.

As the need for help grew more desperate, the Blood Transfusion Betterment Association of New York — which had partially financed the research of Scudder and Drew — joined with the American Red Cross and planned the Blood for Britain project. The Board of Medical Control decided to ask Drew, who had returned to Howard University, to serve as full-time director. He was, the board felt, "best qualified of anyone we know to act in this important development . . . a recognized authority on the subject of blood preservation and blood substitutes and, at the same time, an excellent organizer."

Dr. Drew would have preferred staying at Howard University, teaching Negro medical students and operating at its Freedmen's Hospital. He loved surgery, and he felt that his own people needed him. But on the other hand, a Negro appointed to such an important position could help in the struggle against prejudice and discrimination.

Charles Drew already knew what it was like to be im-

portant, to throw the winning pass in a championship football game, to hear the crowds cheer for him and three other Negroes on the track team as they piled up crucial points. And he also knew what it was like to be told, after the cheers had died away, that an embarrassing situation had arisen in connection with the track-team banquet: no large hotel could be found, in a city named for "God's merciful Providence," that was willing to serve the Negro athletes. Would they mind, they were asked, eating by themselves in the commons of the college? If Dr. Charles Drew should ever be tempted to believe that applause or fame put him in a special category, he would be sure to hear in his memory the words "Would you mind . . . ?" as they hung over the table where four members of the team sat by themselves, in absolute silence.

Dr. Drew had other reasons for accepting the position of director of the project: it would enable him to help in the fight against fascism and to make further contributions in the field of blood transfusions, that is, to save lives.

He knew that lives were being saved, for the plasma was reaching England. However, he wished it were possible for British doctors to send fuller reports; they had no time to write scientific papers or even to compile complete up-to-date statistics. This meant there were bound to be duplications of effort, and that scientific conclusions could not be reached as rapidly as they should.

It also meant that blood donors in America could not know the value of their gifts. He wished that it were possible for every adult to witness a life-saving transfusion. Then more people would give to fill the need that existed in peacetime as well as in war. And perhaps the old superstitions about blood would play a useful role, for men might look upon total strangers and say, "Maybe my blood is flowing in his veins."

The night that Mr. Osgood, having given his blood, was recounting his experience to his friends, a storm blanketed the British coast. Visibility was so poor the enemy aircraft was grounded, and the tired people of London hoped for a good night's rest.

Shortly before dawn, however, the clouds lifted suddenly, and the *Luftwaffe* crossed the Channel in a great wave. Although the weather change had immediately been noted by the British, the warning signals went unheeded by people who were too drugged by sleep — or too fatalistic — to hurry to the shelters.

Most of the bombs fell, as they usually did, on the poorest, most crowded sections of London. One of them scored a direct hit on an old three-story building not far from the banks of the Thames.

Alec Macintosh lived on the ground floor with his daughter and his daughter-in-law and her baby. He had been awake, for who could sleep through the screaming

of the sirens, the antiaircraft fire and the bombs? Yet after the explosion he imagined he had been asleep—that he was a lad again, and his mother had pulled him out of bed because it was time to go to work.

When he came to himself and realized that he was not a boy but an elderly widower, he was out on the street, surrounded by the wreckage of his home, staring up at the sky which was crisscrossed by the probing fingers of searchlights.

Air Raid Precautions workers and neighbors moved hurriedly about him.

"He's all right, only dazed. He got off lucky."

"Mind that smoke over there; get to it before it bursts into flame and gives the Jerries a target."

"There's nothing left to the two upper stories. It got them all before they knew what hit them."

"They're talking about the Hobarts," Alec told himself, and thought wistfully of the pipes he and Cap Hobart used to enjoy together of an evening. Then his head cleared suddenly.

"Rose is inside!" he cried. "Her and the baby. Sarah's working the night shift, but Rose and the baby's inside. You've got to get them out."

"Easy now, mate," a rescue worker told him. "We're doing what we can. Lend a hand here, lads, there's a woman and a child inside, this man says."

A woman neighbor, carrying a bucket of sand, called out, "It's Tom's wife. She's in there somewheres."

"Let me help," Alec cried. "I'm all right now."

"Well then, we can use a hand. All together now: *heave.*"

"Hold that beam while I set a prop under here. Lively now."

The wavering glow from the searchlights came through the gaping hole in the ceiling. It revealed something white under the wreckage — a woman and a child. In a few minutes the men got them out, and then, in a momentary lull, they heard the baby cry. Incredible as it seemed, the child was uninjured, having been protected by her mother's body.

"I'll take her. It's me, Alec, Lizzie Wells, and I'll take care of the poor little thing."

Alec nodded numbly, wondering who would take care of the baby later, with no mother and Tom in the hospital ever since Dunkerque, where he had lost a leg. He was sure Rose was gone, for he had touched her hand and found it cold and clammy.

"Make way for the Sister."

A nurse knelt down beside Rose Macintosh. Sharply she gave orders. "This girl's alive. Fetch the doctor at once; he's down by the corner. Tell him she's too bad off to take to the ambulance — she wouldn't last out the trip to the hospital — so he must come at once."

Within a few minutes the doctor had taken over. Alec stood with a hooded flashlight, directing its beam upon the ground where Rose lay covered with blankets, her feet higher than her head. The doctor stopped the bleeding from the gash in her arm. Now, in the narrow path of

the light from the flashlight Alec was holding, he inserted into her other arm a needle to which a tube was connected.

He stood up, raising his hand to hold aloft something to which the tube was attached. After a moment he told Alec to raise the flashlight, and Alec saw that it was a bottle of what appeared to be a colorless fluid, the level of which was steadily descending. Alec watched it with intensity, although he was certain in his heart that Rose must be dying.

When the flask was empty, the doctor said, "That's it," and knelt down beside the girl, Alec directing the beam so he could see what he was doing. He could scarcely believe it, but Rose's face had changed. There was a little color in it and her eyelids fluttered.

"My baby . . . My baby."

"Your baby's fine, Mrs. Macintosh. Not a scratch on her."

"Dad?"

"Right here, girl. And baby's fine — you're not to fret."

"Tell — tell Tom." To Alec's surprise she managed to raise her head, and the doctor pressed it back gently as she again told Alec to tell Tom.

"We'll take care of everything, Mrs. Macintosh. You'll be seeing your man yourself before very long. You've a nasty cut and some bad bruises, but you'll be all right. I'll give you a bit of morphine to ease the pain so you can rest." He turned to Alec. "Keep her quiet and warm till the stretcher-bearers come for her. She'll be able to stand

the trip to the hospital now. Bad case of shock, but the plasma picked her up."

"Plasma?"

"Blood plasma from the States," the doctor said, assembling his things so he could go on to the next case; the nurse had already left. "It's coming in regularly now and they say we can count on an increased supply. Makes all the difference on a night like this."

"It's made all the difference to my little family," Alec thought. Not far away he heard the explosion of another bomb. "There's all kinds of people," he told himself, "those that drop bombs on us who never did them any harm, and those who sends us their own blood." He looked down at the shadows where his son's wife lay, wondering who it could have been that saved her life; and scenes from American movies came to his mind. A cowboy or an Indian, or perhaps a gangster? "Whoever it was," he thought, "I wish I could shake his hand and thank him and call him brother."

The April 10, 1950, issue of *Time* carried the following notice:

> DIED. Dr. Charles Richard Drew, 45, pioneer in the collection and use of blood plasma, chief surgeon for Washington's Freedmen's Hospital, in an automobile accident; near Burlington, N. C. For supervising New York's blood donations to bombed Britain, and directing the first Red Cross collection unit for the United States armed forces, he won the 1943 Spingarn Award for the highest achievement by an American Negro.

# 13

## *Remodeling the Pump*

### HELEN BROOKE TAUSSIG, 1898–
### ALFRED BLALOCK, 1899–

A SINGLE-MOTORED airplane has no power on which to depend if that one motor fails. Similarly, the body has only one heart. Day in and day out it must contract and relax, pumping blood to the lungs and through the body. If it stops, life soon ceases, too.

It is a small organ for so big a job, weighing from half to three quarters of a pound in adult human beings. It is divided into a right and left side by a partition down the middle; each side is again halved by a horizontal division, with a valve through which the blood passes from the upper to the lower chamber. A large opening in each upper chamber admits the blood from the two main veins; similar openings at the bottom permit the blood to flow out into the main arteries.

The right side of the heart pumps blood to the lungs, where it picks up oxygen and returns to the left side of the heart, which pumps it through the body. In the body

it gives up its oxygen to the tissues and then returns to the right side of the heart again. Actually, then, there are two circulatory systems, the minor one to the lungs, called the pulmonary circulation, and the major one to the body.

More specifically, this is what happens to the blood from the time it flows into the right upper compartment of the heart. (This blood is blue, for that is the natural color of the hemoglobin in some of its cells.) When enough blood has collected in the right upper chamber, its valve opens and lets the blood drop into the right lower chamber. The heart contracts, forcing the blood out into the artery called the "pulmonary trunk," which divides into two pulmonary arteries going to the two lungs.

The blood is then forced through the network of vessels in the air-filled lungs. Here the hemoglobin picks up oxygen, which changes its color to a bright, rich red—cells containing hemoglobin are referred to as "red blood cells," or "red blood corpuscles."

The blood, now a bright red, flows through the pulmonary vein into the upper left compartment of the heart, collects there and drops into the lower chamber. The heart contracts and pumps it through the main artery on this side the aorta, and on through the body. As the blood passes along, the hemoglobin gives up its oxygen to the tissues, which need it to maintain life. The blood becomes blue again and flows on into the main vein, which carries it once more to the upper right chamber of the heart.

This process is repeated over and over again, contin-

uously, throughout one's life. It is speeded up when the body needs more oxygen—for exercising and even for such processes as digestion. If one exercises violently, the body tries to meet the demand for oxygen by filling the lungs more rapidly; when the demand becomes too great, a person may pant and gasp and finally have to rest until the supply can catch up with it.

While it might be possible for a modern engineer to work out a better circulatory system, this one functions pretty efficiently. Of course things can go wrong, as they can with any engine. Disease may scar or injure a valve so that it will not let the blood through fast enough. There may be malformations or flaws which cause a breakdown if the machine is run at top speed. Unfortunately one cannot send to the factory for a new part. Making repairs is like working on a one-motored airplane high in the sky: only the simplest and most essential procedures can be attempted, like sewing up a stab wound that has penetrated the heart's muscles. It is not possible to make complicated repairs on a living, beating heart.

Or is it?

In 1930 Dr. Helen B. Taussig was appointed head of the Children's Heart Clinic at the Johns Hopkins Hospital. A daughter of Bostonian Edith Guild Taussig and of Harvard's famous economist Professor Frank William Taussig, she had written several papers on the heart while she was still a student at the Johns Hopkins Medical School, from which she was graduated in 1927.

In the clinic Dr. Taussig saw a number of tragic cases, among them blue babies — so called because their skin had a purplish blue tinge, either constantly or when they exerted themselves; their lips and blunted fingernails and toenails were a deeper shade of the same color. Every year, about a half dozen of these children would be brought into the clinic — some were infants in whom the condition had been apparent since birth, others were older children in whom it had first revealed itself when they began to crawl or walk.

These babies didn't gain weight properly, and eating seemed to distress them. They were short of breath. Sometimes they failed to learn to walk, or walked with such an effort they could scarcely be persuaded to try; exercising made them gasp and pant and turn quite blue. Since crying was exercise, many of them whimpered instead or whined miserably most of the time. Some of them had fainting spells or went into comas.

"Is his condition serious?" a mother at the clinic would ask. Even if the child did not happen to be blue at the moment, Dr. Taussig would fear, from his listless, unhappy expression and the clublike fingernails, that the answer would have to be "Yes." Blue babies seldom lived very long; it was rare to find one who reached the age of twelve.

"What's wrong with my baby?" the mother would want to know. "What's making him turn blue like this?"

But no one knew exactly what caused the condition — until Dr. Helen Taussig provided the answer.

It was caused, she reasoned, by a faulty circulation to the lungs.

If a heart was malformed so that the blood was prevented from flowing properly through the pulmonary trunk and some of it was forced into the artery running from the other — the left lower — chamber of the heart, some blue blood would mix with the red and flow through the body. Since the blue blood had already given up its oxygen, it would have none for the hungry tissues.

So little blood flows through the lungs of a blue baby that taking a few steps is like running a race to him. Even digesting his food may use up more oxygen than his blood can supply. Panting and gasping does no good because of the limited amount of blood flowing through his lungs. The body tries its best to solve this problem by manufacturing additional hemoglobin cells to do the job; but even this is not enough, and the extra cells create new problems by thickening the blood.

How could this situation be remedied? It would present a fairly simple problem to a plumber or a mechanic. He would take the pump apart, fix up the partition between the right and left halves of the heart so that the blood couldn't flow into the wrong artery, and — if the narrow opening into the pulmonary trunk couldn't be enlarged — weld in a new and larger pipe. To do this he would, of course, have to shut off the engine. The possibility of successfully carrying out such a procedure on a living being was too remote to consider.

Did that mean there was nothing to be done — or could

the problem be solved another way? Could one, somehow, route back some of the blood that should flow into the pulmonary arteries but was going into the other part of the circulatory system? It should be possible to take one of the branches of the main artery running from the left side of the heart and attach it to a hole made in a pulmonary artery beyond the narrow place. Then the blood in this branch would backtrack to the lungs, eking out the supply that was going there by the normal route.

Of course this meant interrupting the circulation to that part of the body supplied by the stream which had been shunted off. But other arteries would take over some of the work it had been doing before; and anyway, it would not matter much, comparatively speaking, if an arm had to get along with a poor blood supply.

It should be possible to hook up the major and the pulmonary circulatory systems. Before a baby is born there is a connection between these two circulations, for an embryo does not breathe air for itself; it gets oxygen from the mother's blood supply. Within a few minutes after birth this connection, which is called the *ductus arteriosus*, closes and begins to shrivel up. Once in a great many cases, it fails to close, leaving this portion of the embryonic circulation still functioning.

In Boston, in 1938, Dr. Robert E. Gross operated upon a young woman with this condition, tying off the *ductus arteriosus*, which then shriveled up as it should have done by itself. This was a famous operation, the first successful attempt at heart surgery. (While it was not actually per-

formed on the heart itself, operations on the circulatory system so close to the heart are called heart operations.)

Connecting a branch of the main artery (the aorta) with the pulmonary artery would, in a sense, be creating the kind of "mistake" which Dr. Gross had corrected. But why not, if it took care of the damage being done by another mistake that could not be corrected? What was important was that sufficient blood should, somehow, reach the lungs of blue babies and enable them to live and grow.

Dr. Helen Taussig's brilliant reasoning had not reached this conclusion in a single burst of inspiration; nor did she, alone, work out the surgical solution to the problem of blue babies.

What happened was that she talked over her idea with Dr. Alfred Blalock when he was appointed chief of surgery at Johns Hopkins in 1941.

Not only was he well qualified for this position, but he was probably the one man best able to recognize the value of her idea. He had had a tremendous amount of experience in surgery of the blood vessels: before returning to Johns Hopkins, from which he, too, had been graduated, he had been professor of surgery at Vanderbilt University Medical School, where he had done research on the relationship between high blood pressure and hardening of the arteries. This had required him to perform many operations on the circulatory systems of dogs, and he had noticed that those whose circulatory systems he altered got along very well.

Dr. Blalock agreed to test Dr. Taussig's theory, and then to work out the surgical procedure.

The latter presented so many grave problems that any surgeon would have felt justified in deciding that it was possible in theory but actually impracticable.

The surgeon would have to work on a small child. He would have to make an incision that, while it would be extremely large in comparison with the size of an infant, would be small compared to a man's hands. He would have to separate the ribs, expose the heart, and open the part of the body containing the lungs, collapsing one of them (which would later be re-expanded). He would have to find the right arteries and dissect them away from their surrounding tissues in order to work with them. He would have to clamp off these arteries to prevent the child from bleeding to death during the time it would take him to cut the one he intended to switch, make a hole in the wall of another, and sew the two together so firmly there would be no leakage and so neatly there would be no rough edges to cause a blood clot later. He would have to do all this rapidly and yet so skillfully as not to cause any unnecessary bruising. And he would have to do it on a child who was far from strong.

Yet he did not say it was impossible.

He had the necessary dexterity and speed as well as the background and ability. Equally important, he had the humility which prevents an expert from thinking he knows enough, and makes him aim for perfection.

Although he had frequently, for other reasons, cut a

blood vessel and joined one end of it to an opening made in another, he practiced continually on dogs whose veins and arteries were about the same size as those of a child. Over and over again he performed the operation.

After a year and a half, he had learned all he could from working on dogs. The time had come to attempt to remodel the human circulatory system, to try to make a miserable blue baby into a healthy pink one.

A physician with a radically new method of treatment always has to face the moment when he must select his subject. Although he may have every reason for confidence, he knows that no one can anticipate everything. Reasoning may be logical and sound; laboratory tests may back it up; a technique may work perfectly on animals—but there is always the possibility that, on a human being, some factor which no one could allow for may enter the picture. If the doctor chooses a patient already at the point of death, he has nothing to fear from his conscience; if he selects one in better condition, he has more chance for success, although he runs the risk of cutting short a life.

There was no dearth of patients for Dr. Taussig and Dr. Blalock to choose from. Most parents, watching the increasing distress of a blue baby, were willing to try anything.

Take Barbara, for example. She had been a blue baby since she was born. When she was nine and a half, she was brought to Baltimore from western New York State on the advice of her physician, who knew of the work of

Dr. Taussig and Dr. Blalock. At the slightest exertion, dark-haired little Barbara would become so winded she couldn't even stand, and would have to squat to try to catch her breath. There was nothing Barbara's family wouldn't do or risk to give her even a taste of childhood. She was over eleven now, which meant that she probably did not have much life ahead of her.

But meanwhile there was a baby whose condition was critical. She had been born prematurely and had gained weight slowly. At eight months she became blue for the first time; and it was soon apparent that she had been born with a serious malformation of the heart. When she ate, her digestive organs required more oxygen than her system could supply, and she would lose consciousness. Before she was a year old, she was admitted to the Harriet Lane Home of the Johns Hopkins Hospital, where it was found that nothing could be done for her and she was sent home. Growing steadily worse, she was readmitted in the middle of August, 1944, and for six weeks she continued to go downhill.

She was by no means a good operative risk, for she was not yet even a year and a half old, and her condition was very poor. She was so small and ill it would not be possible to make laboratory tests, such as checking the amount of red and of blue blood circulating through her body before and after the operation. But without an operation she didn't have a chance.

On November 29, 1944, an operation was performed on this puny infant—the first attempt to remodel

the circulatory system and save the life of a blue baby.

All possible precautions were taken: penicillin to guard against infection, oxygen to enrich the air, a transfusion needle inserted in advance to prevent shock by means of a continuous drip of a saline solution—for which blood would be substituted as needed. Yet one could not be prepared for everything.

How could one guess that the infant's arteries would be so formed as to make it almost impossible to free one for a sufficient distance so that it could be joined to the artery going to a lung?

But it was only *almost* impossible; and so it was done.

Clamping off this artery in order to cut it was not dangerous since there were plenty of others that would continue to carry blood to the body. But there are only two pulmonary arteries, one going to the right and one to the left lung. When one of these arteries was clamped off, the already meager amount of blood going to the baby's lungs would be cut in half.

For thirty minutes two bulldog arterial clamps shut off the blood in the left pulmonary artery while the cut end of the artery the doctors were going to switch was being stitched into the opening in its side—beautifully stitched in the hope of joining these two arteries as though nature had made them that way.

When the bulldog clamps were removed from the pulmonary artery, there was a tense moment, although the blood from the right lower chamber of the heart would simply have to flow over the course it had taken before.

The really critical moment came when the clamp was removed from the left subclavian artery, the artery whose direction had been switched. Now the blood would have to follow a new course, through a joining made by man. Would the stitches hold when the clamp was removed and the blood stream flowed in full force, pulsing and pressing against this spot? If the seam made by the surgeon should burst —

The stitches held. When, at last, the baby was taken from the operating table, her condition was fairly good.

But her left lung, which had had to be collapsed during the operation and then re-expanded, gave a great deal of trouble. For two weeks, only the most devoted care kept her alive. Then, gradually, she began to improve. Since no tests were made, the doctors could go only by the fact that, when she was discharged from the hospital two months later, she was less often blue and her general health had improved. Yet they feared they might have to repeat the operation to bring more blood to her other lung, in order to compensate sufficiently for her very badly malformed heart.

Now it was the turn of little Barbara, eleven and a half years old and in far worse condition than she had been when she first visited the hospital. She tired so easily that she panted while taking the step or two from her wheel chair to the examining table.

On February 3, 1945, Barbara was operated upon. Again there were unforeseeable complications. The structure of her aorta (the main artery) was unusual; it was

almost impossible to find any artery branching off from it that could be used. But again it was only *almost* impossible.

Barbara stood the two-hour-and-forty-minute-long operation very well. She wasn't ill when she came out of the anesthetic; she was even able to eat. Within a few days, the blue began to fade from her skin; slowly the "clubbing" of her fingernails and toenails, caused by lack of circulation to the extremities, improved. More important, in two and a half weeks she could walk. A few days after that she walked sixty feet, holding herself erect, without even panting. On the thirty-eighth day she was discharged from the hospital, a different child from the one who had entered.

The third operation was performed a week after Barbara's, on February 10, 1945. The child was an emaciated boy of six and a half. Always slightly blue, his color deepened when he exerted himself, and so did his distress, so that even though he knew how to walk, he refused to try.

His color actually improved while he was on the operating table. But there were complications. The first bulldog clamp was not large enough, and there was some bleeding before a bigger one could be substituted. When the critical moment arrived and the last clamp was removed, permitting the blood to flow through the joining, some blood leaked out. Fortunately, the stitches didn't burst, but the situation was bad enough. Quickly the clamps were replaced and more stitches added where the blood had seeped through. Would they hold? Again the

clamps were removed. This time there was no bleeding.

The boy's recovery was miraculous. Four days after the operation, his lips, which had been a deep purple, were a bright red. Before he left the hospital, he would not think of refusing to walk; in fact there seemed to be nothing he did not want to try.

These were the three world-famous cases which Dr. Taussig and Dr. Blalock reported under the title "The Surgical Treatment of Malformations of the Heart; Pulmonary Stenosis."

Three times in as many months the doctors had altered a circulatory system. Three children now had been given hearts that were functioning in a manner nature had not intended. But they were functioning. Two doctors had used their brains and their hands, their ingenuity and skill, not to improve on nature, but to get around one of her errors.

Whether the remodeled hearts would work as well and last as long as the perfect ones nature had designed would not be known for many years. But the three operations had been successful. Three times the blue chill of death had been checked and replaced by the pink flush of life. One baby had been given a chance; and a boy and a girl who had been as weary and dispirited as two sick old people were discovering for the first time in their lives what it meant to be children.

# 14

## *Another Army*

THERE is an army in America like, and yet very different from, our military army. It, too, is made up of all kinds of people, some of them highly skilled, others with no more than basic training. There are desk jobs and jobs in the field of action, a great deal of routine work and many exciting moments. The members of this army face death and disablement as other soldiers do, most of them bravely, for they realize that battles and risks always go together.

The differences between this army and military armies are very important. In this case, there is no possibility of coming to terms with the enemy; it must be wiped off the face of the earth. Yet these soldiers are not brutal — in fact, there are pacifists among them — for they are not called upon to take the lives of fellow human beings. They fight *for* life, against disease and death. This is the public health army.

It is a tremendous organization, dealing with all aspects

of health that are too large or complicated or important to be left to individuals, or that are of such a nature that they can be solved only by organized social action. They include such matters as the purity of water and milk, food and drugs; sewage disposal; education and regulations dealing with health and hygiene for mothers, babies, school children and industrial workers; and the prevention and cure of disease.

The main organization of this great army is a government agency, the United States Public Health Service, which has branches specializing in everything from sanitary reports and statistics to scientific research. Similar official agencies in states and communities work closely with it. It is also assisted by unofficial, voluntary agencies like the Red Cross and the National Tuberculosis Association. Most of all, it is helped by doctors outside its ranks.

If more than the average number of babies are dying in some community where there are not enough doctors or nurses, the public health army sends in a corps of volunteers. If typhoid breaks out, the public health department, like a group of trained detectives, tracks down every clue until the source of the disease is located; it may be a broken sewage pipe contaminating the water or ice supply, or sea food from a polluted bed, or a carrier (a person who, without becoming ill, can harbor and pass on a disease germ). Public health workers see to it that children are vaccinated against smallpox, help out when epidemics strike, try to eliminate diseases like tuberculosis by education and early diagnosis, and undertake all

kinds of projects in searching for the cause of cancer and other mysterious killers.

While all of this costs a great deal, it is only a small fraction of the cost of military armies. And the public health army more than pays its own way, for each victory over its enemies results in tremendous savings to our country, not only in life and suffering, but in actual dollars and cents.

The big man sunning himself beside the swimming pool in Georgia was thinking about how much his own illness had cost and was still costing him. In a way this was a strange thing for him to think about because he was a wealthy man and his family did not have to worry about doctors' and hospital bills. A serious illness, however, can turn a man's thoughts in new directions.

He had been very ill indeed. While he was on a vacation with his wife and children, he had suddenly come down with a chill, followed by fever and general misery — the kind of grippe or flu, he thought, that makes one's bones ache. When he got out of bed, he discovered his legs would not support him. A specialist was called in; the diagnosis was "infantile paralysis" — the common name for poliomyelitis.

"Infantile paralysis," the big man repeated. Despite his pain he managed to smile. "I ought to be able to lick a kid's disease," he said. And he did get well; but his legs were paralyzed.

Here, in a tiny place called Warm Springs, Georgia, he

learned how to strengthen his leg muscles so that, with the help of braces, he managed to stand and then to get around with a cane and the arm of a friend. That was much better than having to swing his heavy body about on crutches.

He told other people how much he had been helped by swimming in this pool where the water was warm enough not to cramp the muscles. It was much easier to exercise in the water than it was on land. Gradually, Warm Springs became a center for other victims of paralysis. The Foundation he established paid their expenses when, as so often happened, infantile paralysis proved too expensive for their own pocketbooks.

Yet he realized that the Foundation could help very few of the many people who needed assistance. He had made a large contribution (he would never say how large, but it was estimated at two thirds of his personal fortune), and others had given generously, too; but their gifts were barely scratching the surface of what should be done. It would take far more money than the Foundation could provide or than could be spared by the United States Public Health Service, whose budget had to cover so many things. Proper care would have to be given promptly to victims of poliomyelitis — far more promptly than he, with all his money, had received it. That meant doctors and nurses everywhere had to have special training.

Warm Springs was providing only a sample of the aftercare that was required in order to restore many victims of

the disease to the point that would make the difference between an independent and a dependent life. Research must be undertaken to discover ways of preventing the disease from killing and crippling thousands of people, most of them small children — eventually, to eliminate it entirely. And people must be educated so they would know what to do when it threatened or struck their homes.

None of this would do him any good personally, but that did not prevent the big man with the useless legs from determining that it must be done. He was not discouraged, either, by the fact that everybody said it would be impossible to raise huge sums of money for such a purpose. He was certain that the money could be raised, that all people who could afford to would gladly give something — perhaps a dime — to fight infantile paralysis if they knew how important it was. Fortunately this man was in a position to reach a great many people.

And so, in 1938, an agency was created to help the public health army in its fight against this disease. It was called the National Foundation for Infantile Paralysis, and its founder was the big man with the crippled legs: Franklin Delano Roosevelt, President of the United States.

The public responded generously, and the money given each year to the March of Dimes was a tremendous help to the public health army. It made possible a great many things that could not otherwise have been done.

For example, iron lungs, which cost over $1500 each, are too expensive for many small hospitals, that may

never have a call for one—yet nothing is more essential to a patient stricken with a form of polio that paralyzes the lungs, making it impossible to breathe. With March-of-Dimes money, pools of iron lungs were established in seven cities from which they can now be sent, by plane if necessary, wherever they are required to do a patient's breathing for him. Programs were set up to train doctors and nurses and physical therapists, to improve techniques for preventing limbs from being permanently crippled and for making injured ones as useful as possible.

Families that could never have met the financial burdens of polio were guaranteed the best of care by the Foundation for Infantile Paralysis. Whole towns and cities were also helped. Some of them had been singled out for epidemics year after year until their own resources were exhausted. Others, like little Wytheville, Virginia, were suddenly hit by polio to an extent seventy times as great as that considered to be an epidemic. They could scarcely have managed if the public health army had not come to their rescue with volunteers and arrangements with hospitals in more fortunate areas to care for their sick.

The real task of any army, however, is not merely to care for casualties but to defeat the enemy. And this enemy was steadily advancing. Poliomyelitis was on the increase, although other contagious diseases were being eliminated. While smallpox, for example, had dropped to 34 cases in the entire United States in 1950, there were 34,000 cases of polio during that same year. During the

four years between 1948 and 1952, 132,000 people had been stricken with polio, which was about 18,500 more than the total number of cases during the entire ten years between 1938 and 1948.

Was the antipolio army making some terrible mistake such as the men made who used to fight yellow fever in the old days? They used to station themselves outside a stricken city and shoot anyone trying to escape from it, in order to prevent the plague from spreading, while all the time the mosquitoes that carried the disease flew, humming a song of death, over their heads. This army didn't even know how polio was spread, although they had inspected everything that could be suspected, from flies to milk, and garbage to sneezing.

Yet they had learned a great deal about polio. They had found that it is caused by a virus. This agent of disease is different from the one-celled animals and one-celled plants that cause so many illnesses. Tiny as these plants and animals are, they can be caught by a filter, can usually be seen and identified through a microscope, and can be grown in test tubes and culture dishes filled with broths or jellies. Most viruses, however, go through filters, are too tiny to be seen through a microscope, and won't grow on laboratory foods.

The virus is very mysterious. If you were to select it for a game of twenty questions, you wouldn't be able to say whether it was animal, vegetable, or mineral. It resembles each of these, for it can be grown only in certain soil, like a plant; yet it moves and reproduces like an ani-

mal; and, unlike both plants and animals, it can assume a lifeless, mineral-like form. Being a parasite, it needs a host, whose living cells perform some of the important functions of living for it. Yet it doesn't die when it is on its own.

The polio virus is very particular. It selects only the nerve cells of human beings and monkeys for its home. Since monkeys are very expensive and difficult to work with in laboratories, the doctors who finally managed to get the polio virus to grow in test tubes made a great contribution to polio research. In 1951 it was discovered that there are three different types of polio virus, causing three different varieties of infantile paralysis.

The body, it was shown, fights against polio in the manner which Paul Ehrlich found so fascinating: it creates charmed bullets that strike the invading parasites. Sometimes these bullets (antibodies) rout the invaders before they can do any damage, and in that way countless people have won their battle against polio without even knowing they have had the disease; the blood of many people who do not know they ever had polio has been found to contain these polio antibodies. Many diseases can be caught only once, because antibodies remain on guard. This is true of smallpox and measles, both of which are caused by viruses, and neither of which people get more than once.

Desperately doctors searched for a way to tame the polio virus, to weaken it so that it would be safe to give it to people who would then manufacture antibodies and

become immune. In 1951 a vaccine was prepared from a "safe" polio virus. It seemed to protect monkeys, but it might be years before it would be safe to use on human beings. During those years countless people would be crippled or killed.

Meanwhile, two scientists, a man and a woman, working in two different places with the help of March-of-Dimes money, each made the same discovery. Dr. Dorothy M. Horstmann, of Yale, and Dr. David Bodian, of Johns Hopkins, discovered that the polio virus does not, as had been supposed, go directly to the nerve cells after it enters the body through the nose, throat, and alimentary tract. Instead, it spends some time in the blood stream. Both doctors recognized the importance of this discovery. It is in the nerve cells that the polio virus does its damage, so if it could be fought and conquered during its stay in the blood stream, it could not paralyze its victims.

When a child has been exposed to measles, an injection made from part of the blood of someone who has recovered from that disease will usually supply him with enough antibodies to keep him from getting the disease or to guarantee his having a very mild case. Since so many adults have had measles, the blood in a blood bank is certain to contain antibodies. Antibodies "borrowed" in this way don't last very long, but they can do a lot of good during the comparatively short period of an epidemic.

Like the measles antibodies, the polio antibodies are in

a part of the blood called the "gamma globulin." A scientist in Boston had shown how to extract the gamma globulin from plasma—which would still be good for transfusions. The mixed bloods donated to the American Red Cross were found to contain antibodies of all three types of polio virus.

Dr. Horstmann and Dr. Bodian each tested these antibodies on monkeys by giving them large doses of polio virus. The animals that did not get any antibodies all became paralyzed within three to six days. The animals that got injections of polio antibodies all won their battles against the disease before the virus could get into their nerve cells and cause paralysis. Borrowed antibodies prevented the polio virus from doing any damage. But, of course, monkeys are not people.

Nevertheless, it was worth trying on a human being, for the antibodies couldn't do any harm. Early in September, 1951, a team of forty doctors and nurses headed by Dr. William McD. Hammon, head of the division of epidemiology at the Graduate School of Public Health in Pittsburgh, went to Provo, Utah, to try out gamma globulin. The city was threatened by a severe epidemic of polio, and they hoped that, by giving injections of gamma globulin to some children, and a harmless, useless gelatin to an equal number, they would be able to discover whether the borrowed antibodies worked, and if so, for how long a period.

Beginning on September 4, some 2500 children were given injections of gamma globulin and an equal number

got injections of gelatin. When the epidemic was over, the records were examined to see which group had fared better.

In a sense the Utah test was a matter of "too little and too late." Five thousand is a very small number for scientific purposes, and the epidemic was pretty well under way before the injections were given. But the results were, in the guarded language of the scientists, "not discouraging." Plans were made for a far larger trial to be made early in the next polio season.

As reports of the first polio cases of 1952 came in, the army strategists saw that Houston, Texas, and the surrounding area of Harris County were going to be hard hit. Houston, with a population of almost 600,000, was about the right size for the experiment they had planned.

A team of twenty-five specialists from the National Foundation for Infantile Paralysis headed for Texas. Again under the direction of Dr. Hammon, it included experts from the United States Public Health Service, the Rockefeller Foundation, and various hospitals, and had the full co-operation of the Harris County Medical Society doctors and of local nurses.

Everything was ready to give 35,000 injections, half of them consisting of gamma globulin and the other half of gelatin. The factory preparing the injections had packed twenty-five syringes of each to a box, keeping the serial numbers so that no one would know what any child had received until the experiment was over. Children between the ages of one and six were chosen because fifty per

cent of the polio cases in the area happened to be in that age group. Clinics were set up in eight different parts of Houston and its suburbs. Firemen and members of the National Guard were organized to handle the lines of waiting parents and children.

The project would cost $500,000, contributed to the March of Dimes. It would be the largest polio experiment in medical history, the greatest of its kind ever to be attempted.

That is—if the parents co-operated. Would they respond to the appeals that were being made in every possible manner? Would 35,000 children between the ages of one and six come forth for this great children's crusade? Unless they did, there could be no experiment.

"We can't promise anything except that the injections will do no harm, beyond the brief sting of the needle," the doctors admitted frankly. "We don't know yet whether gamma globulin will help people fight polio."

Even without promises, the parents would have been willing to try anything that might protect their children from polio or its crippling effects. What disturbed them was the fact that their children might not get the possibly-helpful gamma globulin. They stood a fifty-fifty chance of being injected with something completely useless. Why should they subject them to that? Their children were not guinea pigs.

Doctors and nurses and community leaders did their best to explain that the gelatin group was essential to the scientific value of the trials. All experiments had to be

handled that way. There must be two groups, one to test the new method, the other to serve as a control. This was particularly important in polio tests, or there would be no way of knowing whether the results were good because the cases happened to be light ones that season, or poor because a severe form of polio was raging.

"But why can't you compare the group of children that get gamma globulin with those who don't get anything? Why do you have to give some children gelatin?" the parents argued.

There had to be a gelatin group, they were told, so that the comparison could be exact. If parents knew their children had received gamma globulin, they might, for example, let them run more risks of infection than they would otherwise; and doctors who wrote reports of the cases of polio that occurred during the summer might be influenced, one way or the other, if they knew whether or not their patients had received gamma globulin. In a controlled experiment, all the factors in both groups have to be identical except the one that is being tested.

Did the parents understand? Would they realize that even if their children did not get gamma globulin they might be benefited because, if some neighbor's child was protected against the disease, their own children might not be exposed to it? Would they appreciate the far bigger issue that was at stake—what this test might mean to the world? Would they say they were going to bring their children and then simply not appear, because of some unfounded rumor, or because they had decided their own

child would not be missed, or because they simply didn't get around to it?

It was very hot in Houston on the second of July, even before eight o'clock in the morning. Most of the women and children were wearing sun clothes, and the men were coatless.

There was nothing unusual about that. It was unusual, however, to see so many small children accompanied by their mothers — or, occasionally, by their fathers — heading forth at that early hour. School was over for the summer; and besides, these children were too young to be going to school.

They were coming from all parts of the city, in cars and busses or on foot, as though they were answering the call of some Pied Piper. Clothes were fresh and clean; little hands and faces were spotless; vigorously brushed hair was held in place by crisp ribbons or, still showing the ridges left by wet combs, smoothed flat save for the inevitable cowlicks.

When they reached their destinations, they took their places in the lines already forming on the sidewalk. They might have been waiting for tickets to a movie or an early Fourth of July celebration. Yet if one looked closely, one could see that the party spirit was lacking. The smaller children, scarcely more than a year old, naturally had no idea where they were going; but there was no eagerness in the faces of the older ones, many of whom

seemed to be unusually willing to hold their mothers' hands.

As the line in front of the community hall inched slowly forward, the mother of a little boy spoke to the woman in front of her, who had a child in her arms as well as a little girl by her side.

"You must be getting tired holding him," she said. "He looks mighty heavy."

"He sure is; he weighs twenty-seven pounds. But I hate to put him down when he's being quiet for a change."

"He can't even walk yet," the little girl announced. "He's only a baby."

"He's thirteen months," her mother explained, pausing to let the other mother assure her that she would have taken him to be a year and a half old at least. "I wasn't fixing to bring him," she continued. "I thought, why get him upset in all this heat, when they're only starting with them at a year old. But then I decided I might as well; and honestly, I liked to rushed myself to death getting him ready along with Sandy Lee. I was bound to get here at the start so I could hear the Reverrend Summers speak. And I'm sure glad I did. He made me feel I was doing the right thing to bring the children."

"I wanted to hear him too. You know, when they were first telling about this scheme, I wasn't planning to let them do it to my Bobby."

"What made you change your mind?"

Bobby's mother hesitated. "Well, I got to thinking. And

then I remembered this nurse they wrote about in the paper, a girl from up North who came to take care of polio cases, and how she caught it herself and died. A prettier girl you wouldn't want to see, from her picture. And I declare, it made me feel real ashamed to be fussing over doing something just because it might not help my own boy. Compared with what she did, it was little enough to expect of me."

"That's just what my husband said," cried Sandy Lee's mother. "It's little enough for us to do. Our children have a fifty-fifty chance of getting something that may help them, and for the rest — well, if it can help them or others in the future, we ought to be glad to have the chance. And we are."

So were thousands of other parents of Houston and Harris County. Rich and poor, educated and uneducated, they overcame their fears and inertia and the countless things that stand in the way when parents plan to do something. Day after day they brought their children to the clinics.

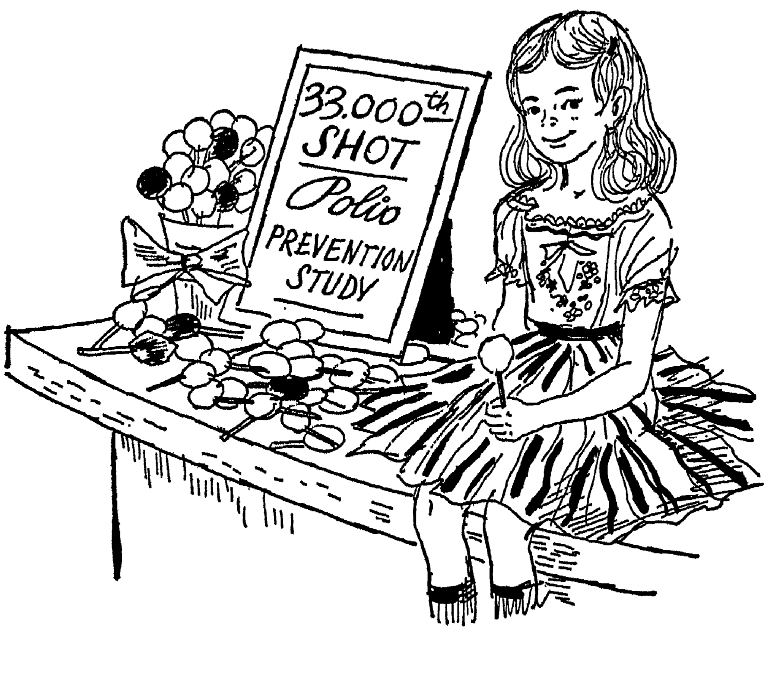
A thousand children, ten thousand, twenty thousand, were quickly and efficiently given their injections. Their outraged cries as the needles stung their posteriors were quickly silenced by the lollipops they received afterward, one for each child until it came to little Connie. She hit the jack pot, a huge bunch of lollipops, because she happened to get the 33,000th injection. She also had her picture taken, looking very pretty in her perky peasant blouse

and the striped skirt spread out over the desk on which she sat, next to the sign saying:

33,000TH SHOT, POLIO PREVENTION STUDY

It took a day longer than they had planned, but on the 12th of July they were close enough to their goal: 33,137 children between the ages of one and six had been injected. Houston's "Operation Lollipop" was a success.

Next it was the turn of Sioux City, Iowa, and the nearby area of Dakota County, Nebraska, which from all indications were going to be even harder hit than Houston.



Here 67 per cent of the victims of polio were between one and eleven years old, and so children in that age group were given injections — 15,868 of them.

The first part of the great experiment was over. Including the children of Provo, Utah, 54,000 children had been given injections, with the consent of their parents. By studying the carefully taken records of every case of polio occurring among these children, it would be possible to tell whether gamma globulin was valuable. Would the children who received it be better able to resist polio than those who had received gelatin? If it struck them, would they have lighter cases, be left without crippling aftereffects? If gamma globulin did work, how long would its effectiveness last?

No one would know until the fall when Dr. Hammon would report the outcome of the polio prevention study.

The year 1952 was especially bad for polio, the worst in history. The public health soldiers, fighting their battles that summer, prayed that the experiment would be a success. The parents who had brought their children to the clinics echoed their prayers. Everyone who had heard or read about the trials waited anxiously for the results.

On the morning of October 22, 1952, the delegates and visitors to the annual meeting of the American Public Health Association, held in Cleveland, Ohio, heard the long-awaited report of Dr. William Hammon.

During the first week following the injections, he said, the children receiving gamma globulin were scarcely, if

at all, protected against polio; nearly as many of them came down with it as did children who had received only gelatin. However, their cases were milder. Within thirty days, half of them had recovered completely, whereas not one of the other polio victims in the experiment recovered in that length of time.

"During the second week," he continued, "there was a marked difference between the number of polio cases in the gamma-globulin and in the gelatin groups — three and twenty-three cases, respectively. The reduction appears to be greatest during this week, but protection appears to have continued during the fifth week. From the second to the fifth week, only six cases occurred among those receiving gamma globulin, and thirty-eight among those receiving gelatin. This difference is highly significant."

It was indeed. Of course there were still a great many questions to be answered: would a second shot help for another six-weeks period, and could enough gamma globulin be obtained to help children everywhere? (It was estimated that an additional 2,000,000 pints of blood would have to be donated in order to provide gamma globulin for the country's 46,000,000 young people.)

Nevertheless, people all over the country rejoiced when they read the story appearing on the front pages of their newspapers. Between the second and the fifth week, 61 children in the control group caught polio, as compared with 9 of the children who had been given gamma globulin — almost seven times as many. For the first time in

medical history, a "material has been scientifically proved to be effective in preventing human paralytic polio."

The names of William McD. Hammon, Dorothy M. Horstmann and David Bodian could be placed under the title of this story. Not very long ago historians used to say that a certain war was won because of the brilliant strategy of a great general, and another one by the heroism of a soldier who inspired his comrades. Lately, however, we have come to realize that victories depend on many things, great and small—upon the contributions of civilians as well as soldiers.

In whatever way victory may come in the war against polio, it will belong to all those who have contributed to it. Some contributions will have been greater than others; but everyone will have helped, from the nurse who gave her life and the scientist who solved a part of the puzzle to the child who dropped a dime into a collection box.

The credit, then, belongs to the person who is the real hero of every army. All the adventures in this book should honor that hero, and this adventure most of all.

And so the place under the title of this story belongs to

The Unknown Soldier<br>in the War against Disease